Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING — October 1944 — PITTSBURGH, PA.

TECHNOLOGY DEPT: PUBLIC LIBRARY

MESTA BAR MILLS

Mesta 36" Roughing Mill for supplying billets to the 32" Bar Mill Stands in the Chicago District's new electric steel plant.

The Army-Navy "E" Flag with four stars, flies over the Mesta Plant

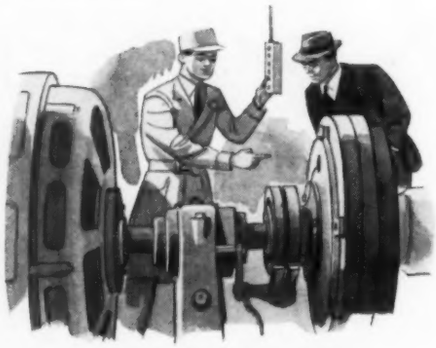
MESTA MACHINE COMPANY · PITTSBURGH, PA.

Wondering about Electronics?

your start may be MAGNETICS

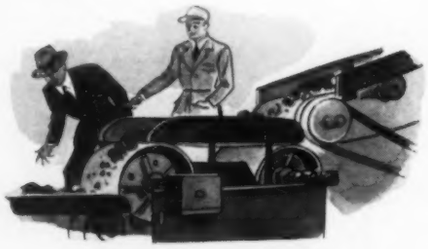
MAGNETIC LIFTING

Do you want to solve a problem of lifting and handling bagged, boxed or bare iron and steel parts? Then look for an answer in the Cutler-Hammer line of lifting magnets . . . every type, from 5 inches up to 6 feet in diameter.



MAGNETIC CLUTCHING

To start and stop machines smoothly, automatically, investigate C-H Magnetic Clutches. All mechanical clutch functions plus many extra advantages. Remote control by pushbutton or automatic means. Superior where speed relationship is fixed or space at a premium.



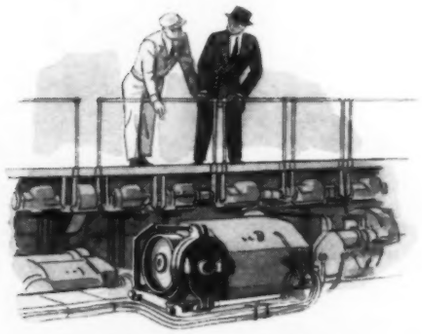
MAGNETIC SORTING

To keep materials in process free . . . to protect valuable machinery . . . from stray pieces of iron or steel, use a Cutler-Hammer Magnetic Separator. Can be installed as part of continuous conveyor line. Valuable in salvaging scrap from refuse, etc.

Builders of all kinds of machines are deeply interested in the possibilities of *electronic* controls. But before any machine may use electronics, it must be *electrically* operated to make such control possible. Magnetics can be the bridge between mechanics and electronics. Possibly that is the very point where your redesign work should start. Cutler-Hammer engineers have pioneered in both magnetics and electronics. They have built magnetic clutches as small as your hand and others bigger than a man. Their magnetic brakes are used in steel mills and other industries throughout the world. C-H magnetic separators are used in a wide variety of processes. Cutler-Hammer built the world's largest lifting magnets . . . and the majority of those of smaller size. If you think your machines should now employ electronic controls or might be improved simply with magnetics, discuss your problem with a Cutler-Hammer engineer. His counsel will be useful because his recommendations will be practical . . . based on experience. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ont.

Engineering Excellence Finds its Greatest Reward in the Respect and Confidence of those it Serves

CUTLER-HAMMER
MOTOR CONTROL
C-H



MAGNETIC BRAKING

Where machines must be stopped, automatically, quickly, without a jar, use a C-H Magnetic Brake. Pushbutton or automatic control. Action smoothly cushioned, operation positive and assured. For hoists and cranes or wherever loads are to be held or machines stopped.

STRUCTS HIS MEN . . . *"The customer wants the most efficient straightening press you can design. Don't rely on conventional methods—make your design better than any press in use today. And remember, the customer is not a customer yet. Your work must compete with other firms and the best treatment will earn the contract."*

Aetna-Standard hydraulic straightening presses are available in capacities from 25 to 250 tons

Aetna-Standard Incorporates New Design Features in Oil Hydraulic Straightening Presses

Aetna-Standard did get the job on the basis of design, which included eight outstanding features:

1. Automatic dual pump system to give rapid approach and return high pressure working stroke.
2. Adjustable ram pressure from zero to maximum press capacity.
3. Convenient location of pump unit to provide easy accessibility for making adjustments.
4. All-steel cylinders with centrifugally cast manganese bronze cylinder bodies.
5. One-piece construction in table and main frame—no bolted connections.
6. Long straightening table with full depth, complete with oil actuated feed rollers and anvil assemblies.
7. Conservative stresses with only negligible deflections.
8. All welded, stress relieved construction, to guarantee rigidity.

The presses now in operation at Reynolds Metals Company emphasize Aetna-Standard's wide scope of operations. Although better known for tube mills, drawbenches and similar equipment, Aetna-Standard makes all types of equipment for the steel, non-ferrous and chemical industries. In fact, straightening presses are not new with us since we always have made mechanically-operated presses. And in connection with hydraulic equipment, we produce hydraulic squeeze pointers, hydraulic stretcher levellers, hydraulic pipe crushers, etc.

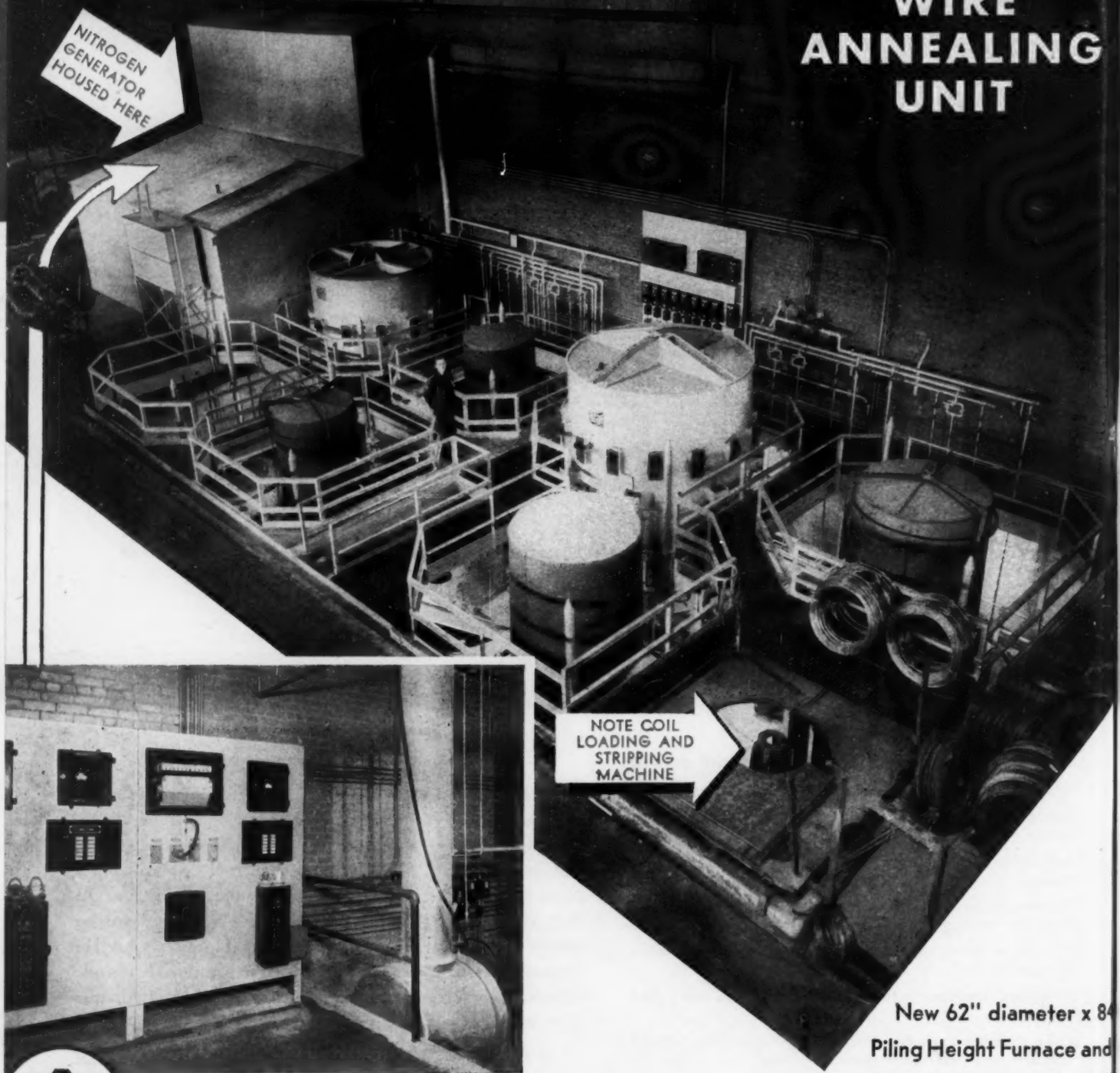
When you want the conventional or the unconventional in machinery, call on Aetna-Standard.

THE AETNA•STANDARD
ENGINEERING COMPANY
YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Sheffield Steel adds another WILSON WIRE ANNEALING UNIT



Control Room. Temperature Control and CO_2 Stripping Apparatus

New 62" diameter x 84
Piling Height Furnace and
Bases in foreground, at th
Kansas City, Mo., plan

The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,089,843, and other patents pending

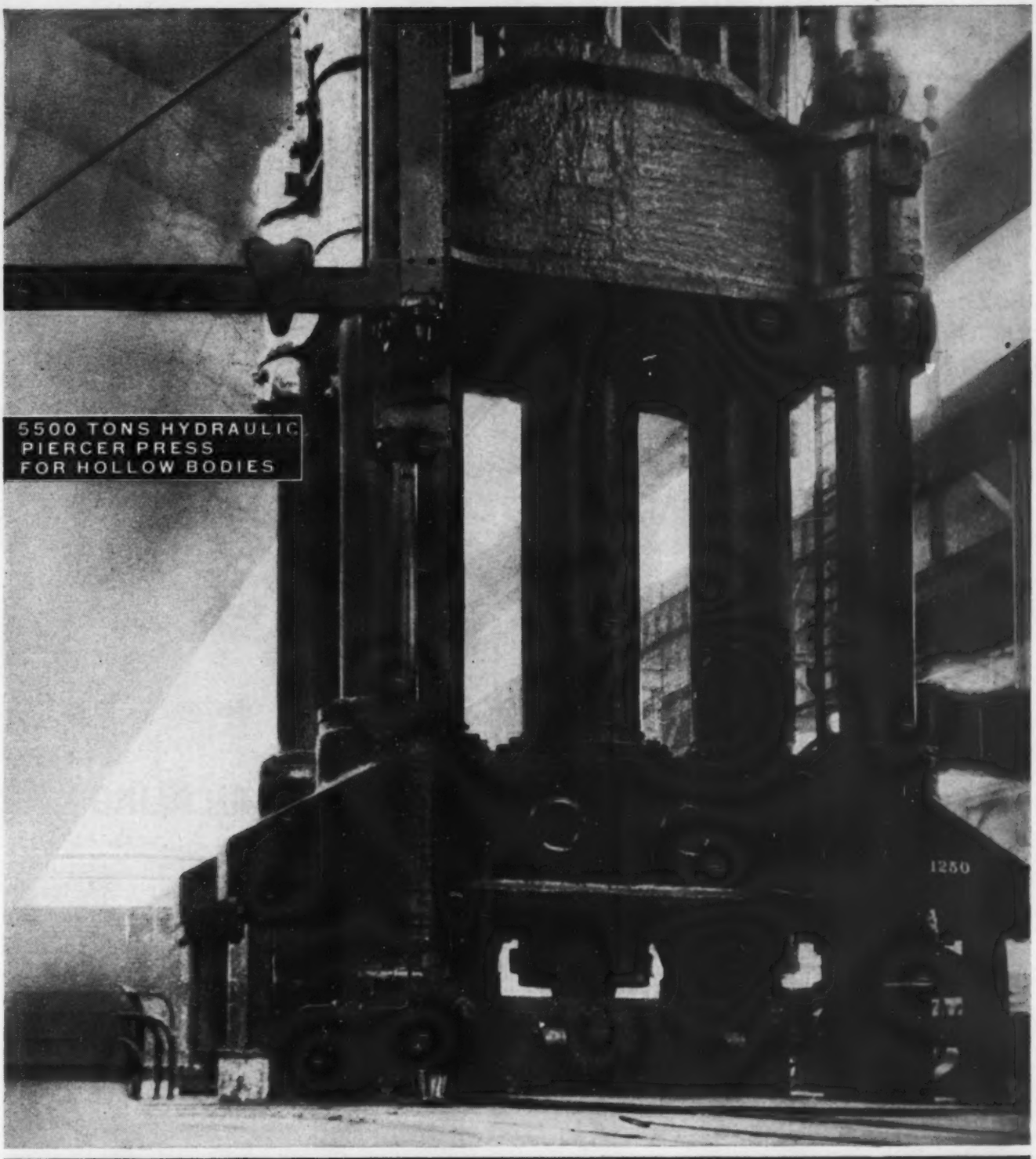
ENGINEERED AND CONSTRUCTED

Lee Wilson ENGINEERING Co., In

20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES · RADIANT TUBE HEATING · HEAT TREATING PROCES



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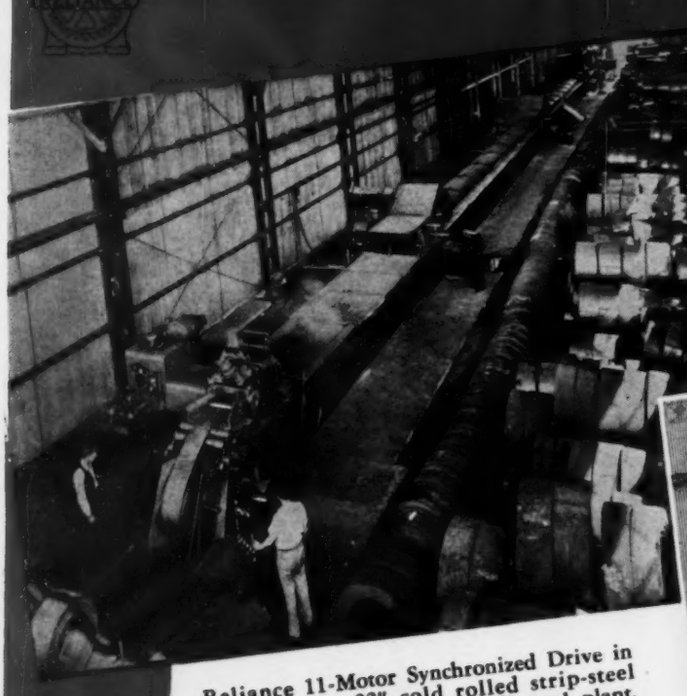
ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

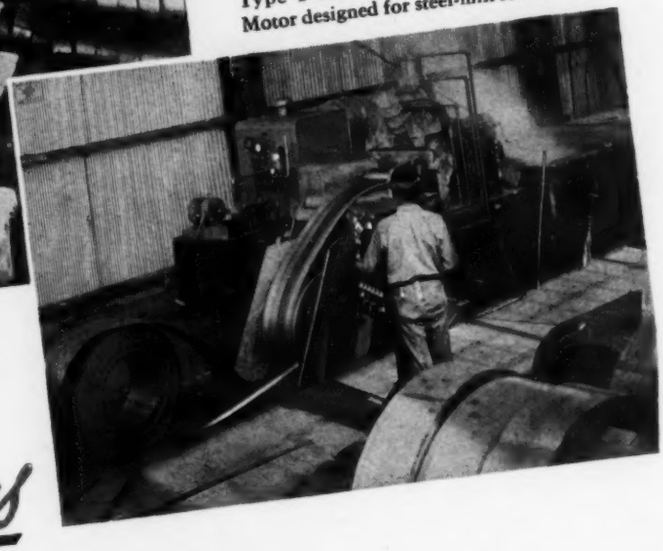
570 LEXINGTON AVENUE · NEW YORK · N. Y.

"MOTOR-DRIVE IS MORE THAN POWER"

Type T Heavy-duty Reliance D-c. Motor designed for steel-mill service.



Reliance 11-Motor Synchronized Drive in operation on 22" cold rolled strip-steel pickling line at a mid-western steel plant.



10% Speed Bonus

ON SEMI-CONTINUOUS PICKLING LINE

Reliance Heavy Duty Type T D-c. Motors and Type AA Induction Motors combine to operate the leveler pinch rolls and coilers in this semi-continuous pickling line.

The line is stopped and jogged both forward and reverse at any desired speed from "slow" to "maximum", by Reliance Synchronized V★S Drive controlled from centralized push-button panels.

The extremely smooth and rapid acceleration and deceleration of this Reliance installation has made it possible for the pickling line to be run 10% faster than originally planned. The results have been extremely satisfactory, proving again that "Motor Drive is More than Power."

A Reliance engineer will be glad to discuss with you the details of this installation, or, what's even more important, how Reliance V★S Drive can be profitably applied to your own operations.

RELIANCE ELECTRIC & ENGINEERING COMPANY
1088 Ivanhoe Road • Cleveland 10, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S.C.) • Houston • Los Angeles • Minneapolis • New York
Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • Salt Lake City • San Francisco • Syracuse • Washington, D.C. • other principal cities

RELIANCE A-C D-C MOTORS

SWINDELL DESIGNS AND BUILDS ONE OF THE WORLD'S LARGEST *Open Hearth* INSTALLATIONS

PROOF OF THE OUTSTANDING ENGINEERING ABILITY AND EXPERIENCE AVAILABLE AT SWINDELL

Open Hearth floor and three of the many furnace doors at the Carnegie-Illinois Steel Company at Homestead.

Every Swindell installation embodies these satisfactory performance features:

- *Advanced engineering design*
- *Complete accuracy of control*
- *Continuous, maximum production*
- *Low operating and maintenance costs*
- *Designed for labor minumum*

Swindell engineers will gladly discuss furnace modernization, or new construction, with Steelmakers, anytime, anywhere.

SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH, PA.

The investment with a GUARANTEED future

BUY MORE WAR BONDS!

*Extreme

"Tycol EP Lubricants" have proved in extensive field applications their ability to more than meet the requirements of the services for which they are recommended.

Let a Tide Water engineer help you select the proper Tycol lubricant for your needs. His familiarity with Tycol's complete line of lubricants – plus his extensive experience in all phases of industrial lubrication – is your assurance of trouble-free lubrication. Call or write your nearest Tide Water office for further information.

TIDE WATER ASSOCIATED OIL COMPANY

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL • Eastern Division: 17 Battery Place, New York 4, N. Y.

Principal Branch Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.

SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE **TYCOL**

PRESSURE (No 2)

* This is the 12th of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.

TIDE WATER LUBRICANIA

DEFINITION: Extreme Pressure Lubricants are lubricants which, under certain operating conditions, permit carrying of loads greater than can be supported by mineral oils of similar viscosity.

This property of greatly increased load carrying capacity may be imparted by incorporation of suitable addition agents. The merits of EP Lubricants are defined by test and performance, rather than by chemical composition alone.

NOTE: The slight increase in load carrying ability which occurs when fatty oils are added to mineral oils is not sufficient to justify such products being termed Extreme Pressure Lubricants.

LABORATORY TEST METHODS: A number of laboratory machines are used for measuring load carrying capacity of lubricants. A series of EP Lubricants evaluated by these machines may not be rated necessarily in the same order, presumably because of differences in design and details of operation among the machines. Caution must be observed in interpreting results derived from any of these individual test methods. The degree of correlation claimed between results from laboratory measurements and those from field performance has not been positively established.

Among the more common machines employed in the laboratory to evaluate load carrying capacity of lubricants are:

The Timken Tester
The Almen Machine
The Falex Lubricant Tester
The Floyd Machine
The Four Ball Machine and
The S.A.E. Machine

At times each type of apparatus has been claimed by its proponents to be a reliable means of evaluating lubricants for a given use. No one machine is recognized generally by technologists as an exact means for predicting field performance of lubricants in all types of service. However, by using any one test machine to compare a lubricant of unknown merit with others of known service performance in a restricted field, some indication of the utility of the unknown lubricant may be secured.

S.A.E. machine for testing EP lubricants, one of many machines used for this purpose.

TYCOL

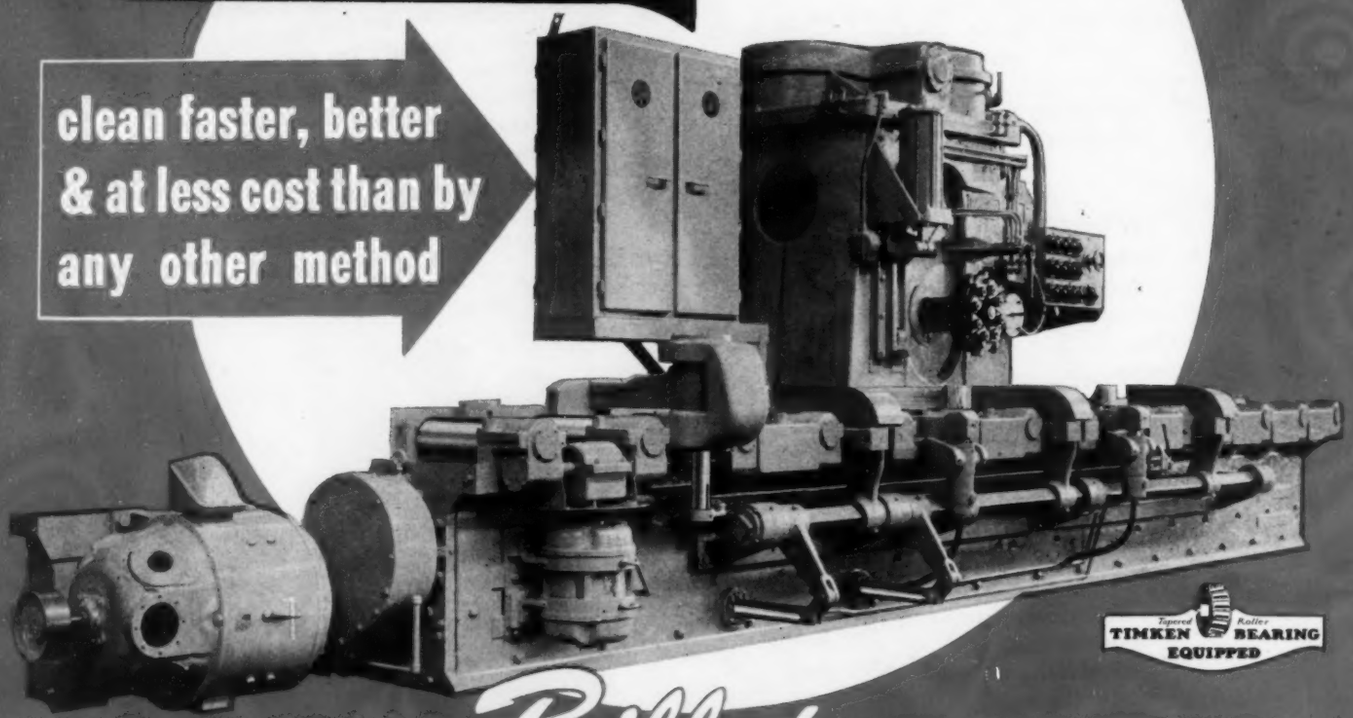
Gasoline Powers the Attack — Don't Waste A Drop

INDUSTRIAL LUBRICANTS

If you Judge Mill Equipment by its Savings Per Ton, We Have User Facts That Prove Billeteers will—

FASTER BETTER LESS COST

clean faster, better & at less cost than by any other method



Tapered Roller TIMKEN BEARING EQUIPPED

INVESTIGATE *Billeteer* ECONOMIES

STEEL EQUIPMENT DIVISION OF THE BONNOT COMPANY, CANTON, OHIO

BONNOT

ENGINEERED FOR IMPROVED PRODUCTION

WRITE FOR COMPLETE FACTS

MONTHLY TONNAGE REPORT
SERIES 4000
FOR LIGHT and MEDIUM SCARFING
SERIES 5200
FOR REMOVAL OF LARGE AREAS OR HEAVY WASHING
SERIES 6100
FOR HEAVY SLAB SKINNING OR PREHEATED STEELS

3 keys TO BETTER SCARFING TONNAGE FIGURES

As pioneers in the development of the oxyacetylene process of surface conditioning blooms, slabs and billets preparatory to rolling, Airco has continued to perfect the apparatus required for its practical application.

The three flame scarfing torches shown above are good examples of that Airco service to the steel industry. They represent the combined effort of the Airco Apparatus Research Department, Airco's Field Engineering Service Staff and practical steel makers to provide the most efficient equipment for light, standard or heavy hand deseaming.

They are designed for billet shed service, light but sturdy and balanced to enable the operator to work with maximum speed and efficiency.

Ask your nearest Airco office for new catalog circular illustrating and describing these three important aids to better scarfing tonnage figures — or write direct to Dept. IS.

★ BUY UNITED STATES WAR BONDS ★

AIRCO

AIR REDUCTION

General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.

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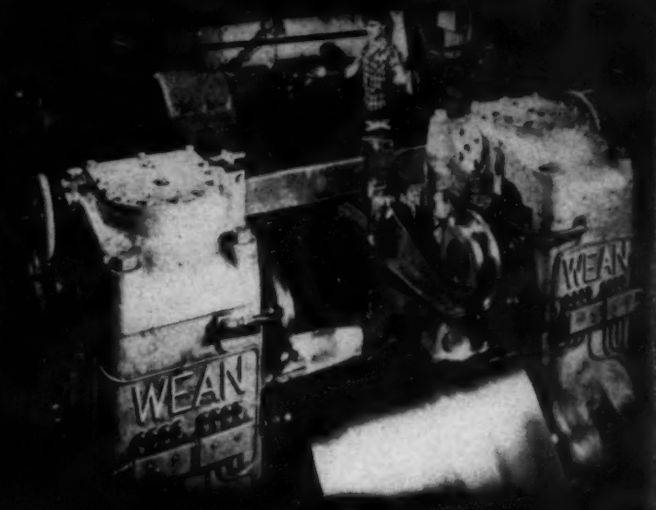
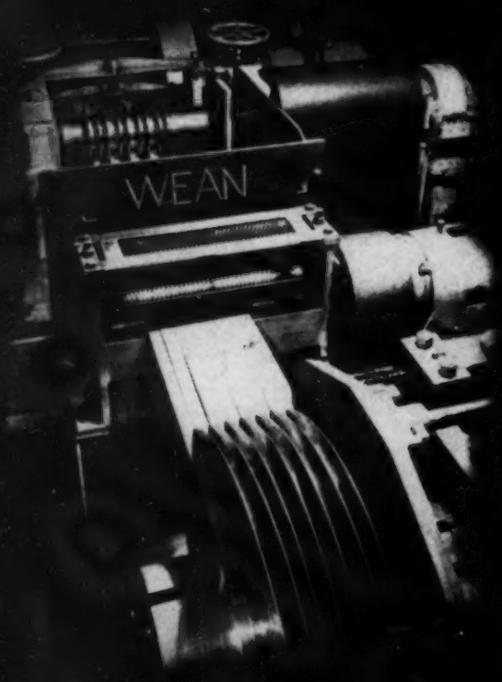
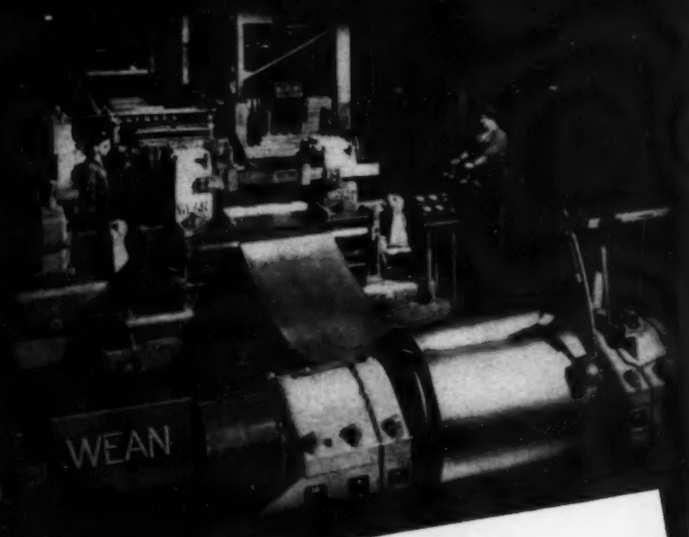
WEAN

SHEARING, SIDE TRIMMING AND SLITTING EQUIPMENT *for* STRIP STEEL



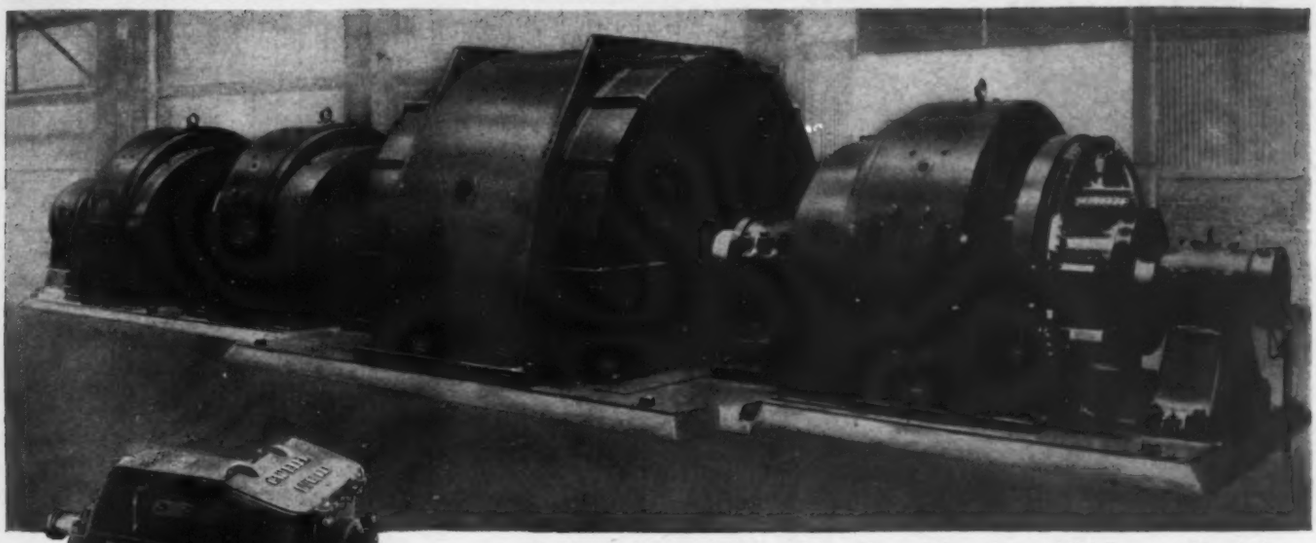




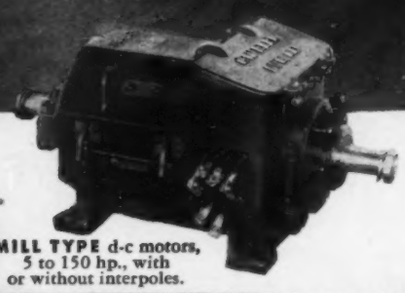
THE WEAN ENGINEERING CO., INC.
WARREN, OHIO

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

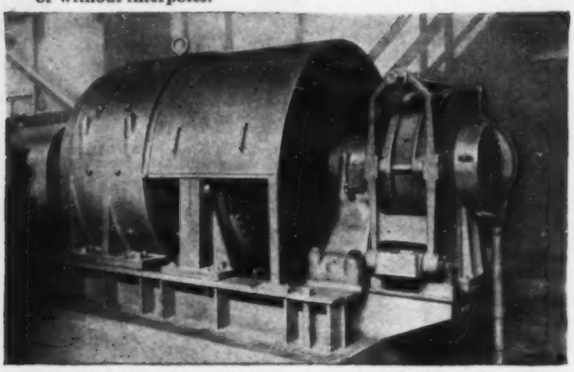
CROCKER-WHEELER POWER for IRON and STEEL INDUSTRY



D-C POWER SUPPLY for a modern mill consisting of two 1250 kilowatt, 600 volt d-c generators and one 1,000 kilowatt, 250 volt d-c generator, all driven by a 4,800 kilovolt-ampere, 6,600 volt, 25 cycle, 3 phase synchronous motor.



MILL TYPE d-c motors, 5 to 150 hp., with or without interpoles.



TAILORED d-c drives for important auxiliaries such as the 700 horsepower, 500 rpm slab squeezer drive motor, above, provide the flexibility of power and speed necessary for maximum all-out production.

CROCKER-WHEELER motors and generators help sustain the all-time high degree of electrification of the steel industry. This "know-how" of electrification involves many separate applications of C-W through their pioneering of engineering development and initiative.

The complete line of C-W motors made specifically for the steel industry covers every phase of the many steel making processes. They are completely encased in a tight, thick steel housing, larger sizes are force ventilated which keeps out all dust, dirt, abrasives, steel chips and filings. Vacuum impregnation with high grade varnish further protects the windings from corrosive fumes and other harmful conditions.

Each C-W motor and generator is liberally designed with the highest engineering skill and built with proven manufacturing integrity for the specific task it is called upon to perform. Let the C-W engineer solve your problem created by today's needs or your reconversion plans. Let us work hand in hand—to make the steel roll faster...faster!

CROCKER WHEELER Motors Generators

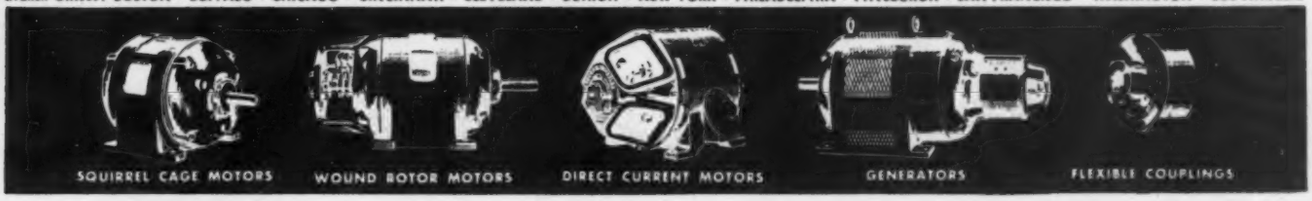
JOSHUA HENDY IRON WORKS

CROCKER-WHEELER DIVISION

ESTABLISHED 1856

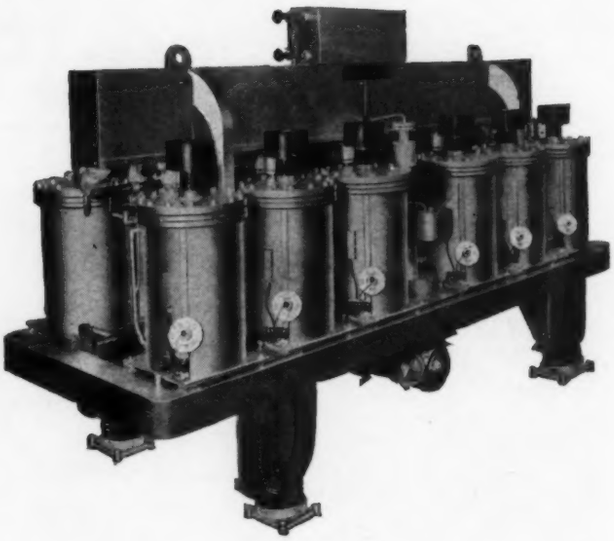
AMPERE, NEW JERSEY

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON • LOS ANGELES



PARTS *that normally wear*

AREN'T THERE



The parts that normally wear on power conversion equipment aren't present in Westinghouse Ignitron Rectifiers. No major wearing parts . . . so, naturally, maintenance is at a minimum.

No air ducts or ventilating systems are required. Voltage control is simple—manual or automatic.

Add to this the other advantages listed below, and you'll see why Ignitrons—a product of Westinghouse Electronic Research—are now supplying d-c power for a majority of America's vital war industries. Westinghouse engineers are busy making Ignitrons even more efficient and compact—to meet d-c power demands certain to come with industrial reconversion.

IN THE STEEL INDUSTRY

High load swings with extreme overloads and frequent short circuits are normal operating conditions for steel mill conversion equipment. Ignitron Rectifiers withstand extremely high momentary overloads and short circuits without damage to the equipment and without increase in maintenance.

For further information, write for Book B-3024. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

J-10259-1

Westinghouse

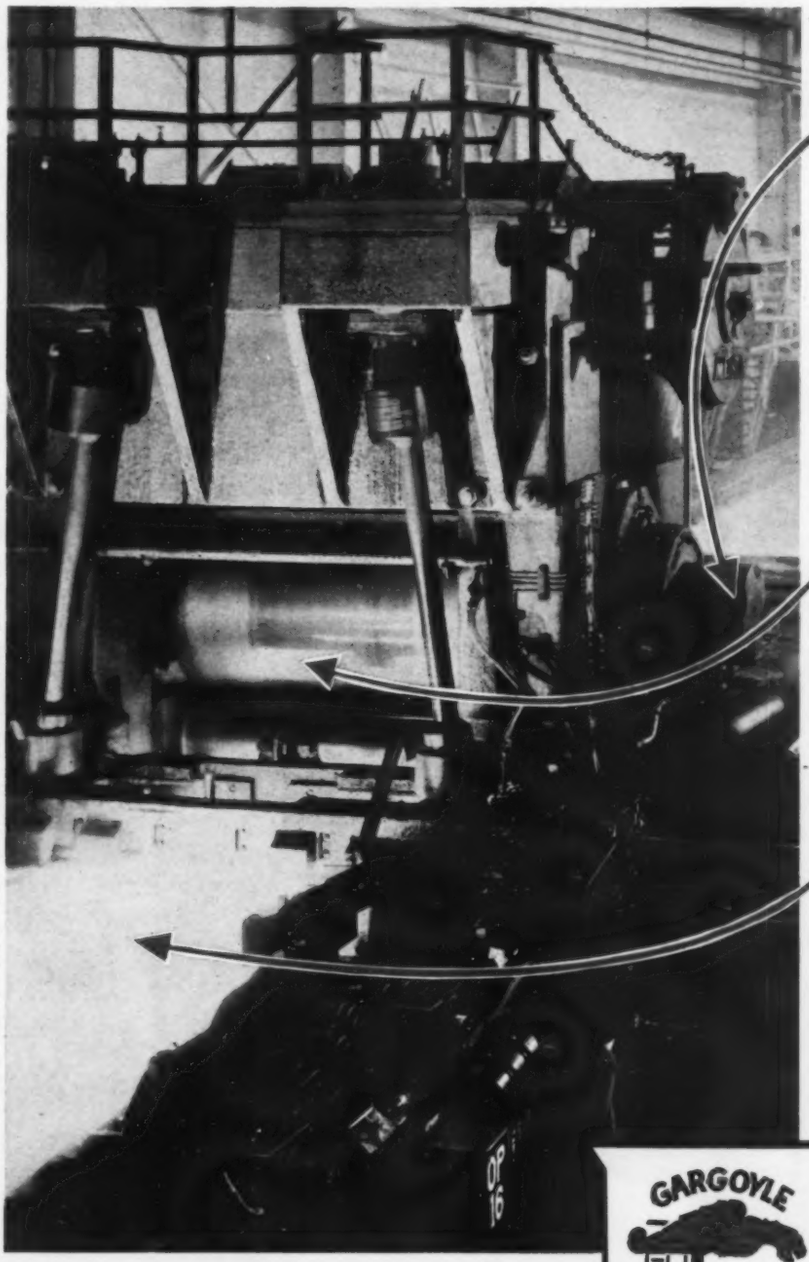
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

IGNITRON RECTIFIERS

Electronics at Work

HOW TO SOLVE OPERATING PROBLEMS WITH *Correct Lubrication*

New Patented Grease Meets These Steel Mill Conditions:



ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION

Crushing Pressures

Specially developed for heavy-duty steel mill service, Gargoyle Grease Sovarex L, meets the crushing pressures and constant shock loads on back-up rolls, work rolls and table rolls. It stands up under heavier pressures than any other grease, provides greater protection against wear and permits increased production by reducing "downtime" for repairs and replacements.

Washing Action of Water

Even though water pours over bearings, Gargoyle Grease Sovarex L sticks on the job. This built-in resistance to water protects costly bearings against corrosion and rust, helps keep production rolling and contributes to reduced maintenance time and expense.

Extreme High Temperatures

In service now in many mills, Gargoyle Grease Sovarex L, is standing up under temperatures as high as 450° F. This means continuous protection for bearings and it also means reduced leakage and lower lubrication costs. This is an exclusive product, developed and patented by Socony-Vacuum. Get full details on this special steel mill lubricant from your Socony-Vacuum representative.

SOCONY-VACUUM OIL CO., INC.
Standard Oil of N.Y. Div. · White Star Div. Lubrite Div. · Chicago Div. · White Eagle Div. · Wadhams Div. · Magnolia Petroleum Co. · General Petroleum Corp. of California.

GARGOYLE Lubricants

Call in Socony-Vacuum for New Patented

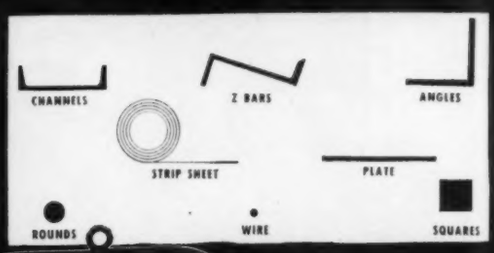
GARGOYLE GREASE SOVAREX L

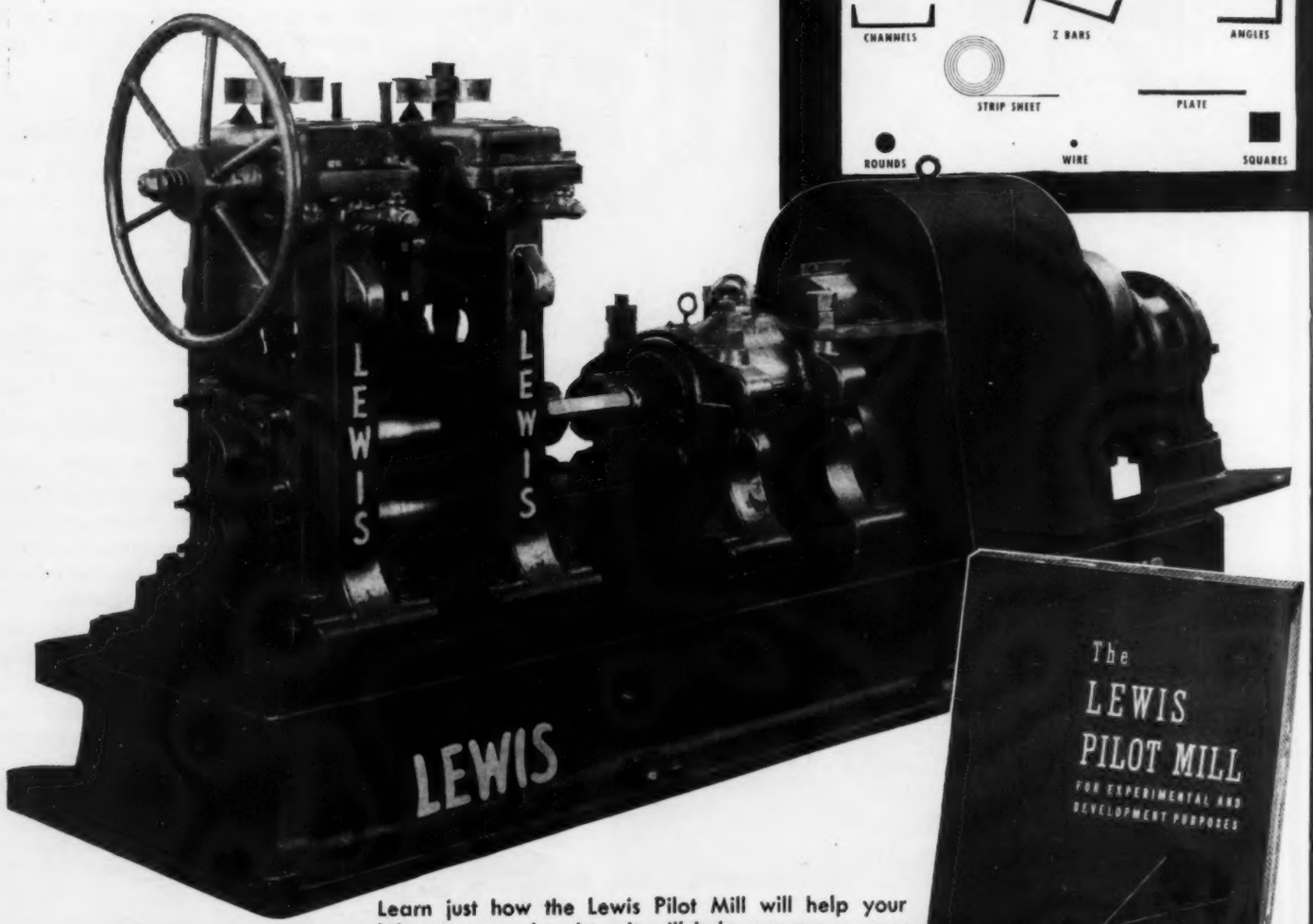
LEWIS PILOT MILLS are precision instruments for conducting accurate research work on the many problems encountered in the rolling of ferrous and non-ferrous metals.

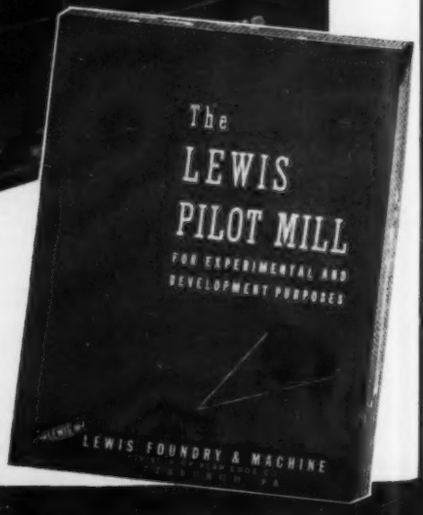
At a minimum of capital risk you can now compile invaluable data on rolling techniques required for the new alloys of steel, aluminum, magnesium, brass, copper, zinc, etc., through laboratory trials on this versatile pilot mill. It is capable of rolling Channels, Z-Bars, Angles, Strip Sheet, Plate, Rounds, Wires and Squares.

THE LEWIS PILOT MILL

for Experimental Rolling of Flats and Shapes







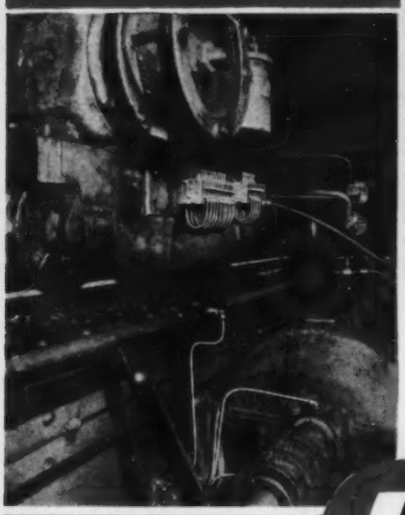
Learn just how the Lewis Pilot Mill will help your laboratory work — how it will help you prove your rolling processes prior to full-scale rolling mill investment . . . Write us today for new Catalog No. 1990.

LEWIS ROLLS step up tonnage

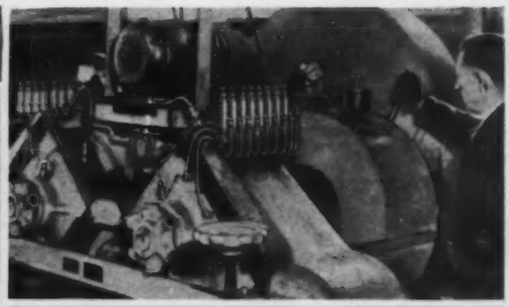
LEWIS FOUNDRY & MACHINE

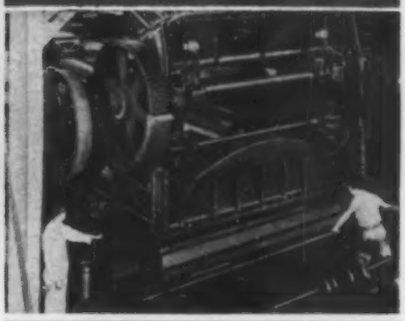
DIVISION OF BLAW-KNOX CO.

PITTSBURGH, PA.



KLING ANGLE SHEAR



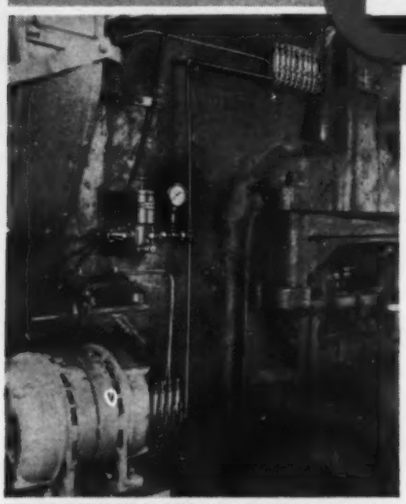


TOLEDO PRESS

ALL MACHINES IN THIS PLANT ARE EQUIPPED WITH

LINCOLN

15-TON CASE CRANE

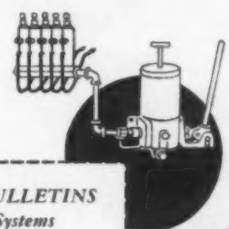


THOMAS SPACING MACHINE

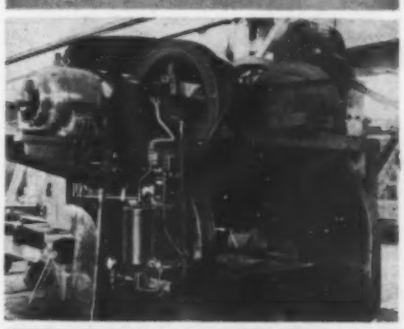
CENTRO-MATIC LUBRICATING SYSTEMS

A leading steel fabricating plant in the midwest* installed a Lincoln Centro-Matic System on one of their large presses. They were so impressed with the increased efficiency provided by the installation that they immediately installed Centro-Matic Lubrication Systems on all machines, cranes and plant equipment that required lubrication. This is only one of the many plants equipped throughout with Centro-Matic Lubricating Systems.

Lincoln Centro-Matic Lubricating Systems consist of a number of Centro-Matic Injectors —one for each bearing . . . and a hand-operated, or a power-operated Centro-Matic Lubricant Pump. The systems are easy to install and no special tools are necessary.



THOMAS DUPLICATOR



BERTSCH PLATE SHEAR

*Name upon request

Send for These Bulletins

Plan today to increase your plant lubrication efficiency. Send for these informative bulletins. The coupon is for your convenience.

I WOULD LIKE TO HAVE FREE BULLETINS
On Lincoln Centro-Matic Lubricating Systems

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

ISE 144-15

ARMY E NAVY

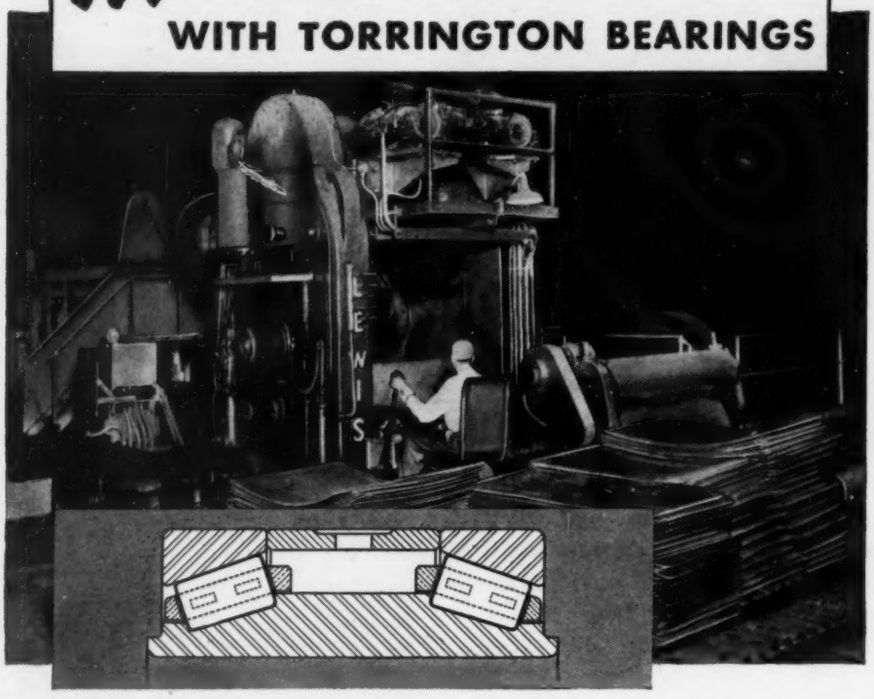
LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

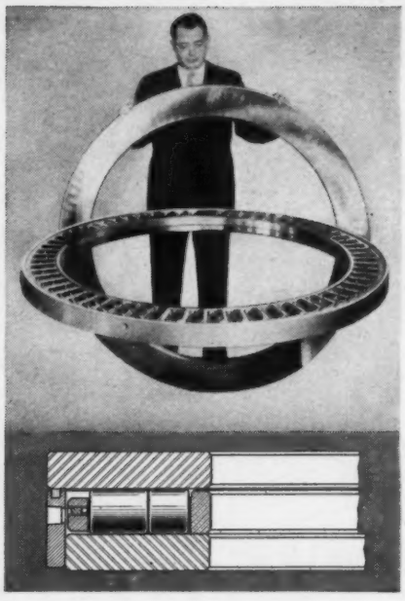
5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

LINCOLN

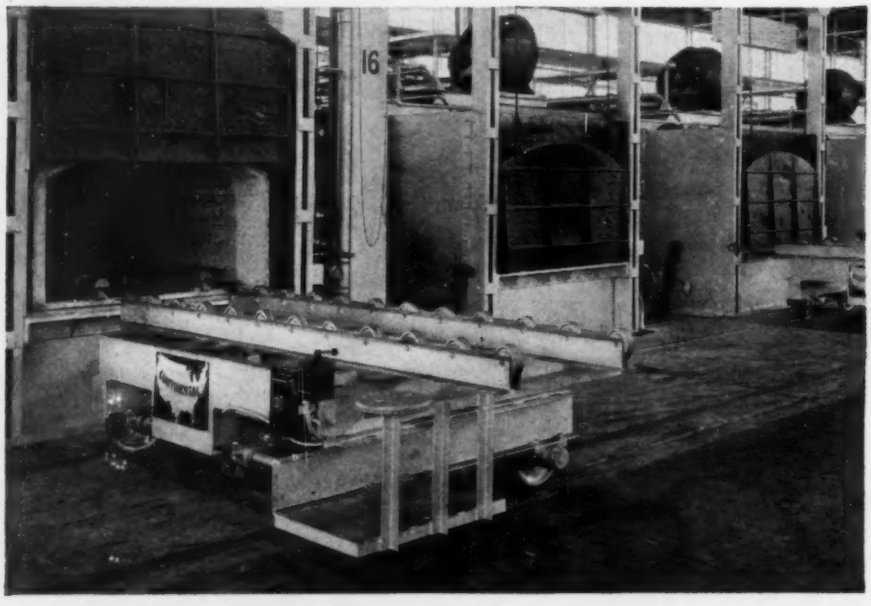
IN THE NEWS
WITH TORRINGTON BEARINGS



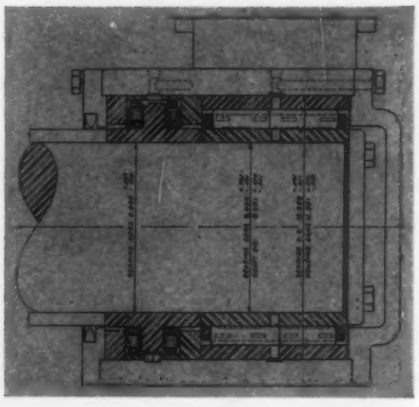
THIS THREE-HIGH ROUGHING BREAKDOWN SHEET MILL, built by Lewis Foundry & Machine, is equipped with two-row tapered roller bearings, supplied by Torrington's Bantam Bearings Division, as shown in the accompanying cross-section. With each row employing 34 rollers, 1⅞" long and 1-3/32" in diameter, these bearings have a radial load capacity of 216,200 pounds; a thrust load capacity of 148,900 pounds at 100 R. P. M.



BUILDING HUGE ANTI-FRICTION UNITS, such as this roller thrust bearing, measuring 53.125" O.D., typifies the ability of Torrington engineers to design large bearings to carry extremely heavy loads. With its assembly including 68 rollers 2" long and 1.5" in diameter; 68 rollers 1.375" long and 1.5" in diameter, the unit is employed in the revolving mechanism of a charging crane which serves the plate mill pre-heating furnace in one of the nation's leading steel plants. Cross-section shows how felt packing was used to prevent entrance of scale and foreign matter during operation of the crane.



FAST ANNEALING of iron alloys is accomplished by these furnaces designed and built for rapid handling of work by the Continental Industrial Engineers, Inc. Metal to be heat treated glides smoothly into the furnace on easy-turning rollers. Each roller turns on an anti-friction unit assembled from Torrington Type LN Needle Rollers. A hardened sleeve, also supplied by Torrington's Bantam Bearings Division, forms the outer raceway.



CARRYING A 270,000 POUND RADIAL LOAD and 168,000 pound thrust load, this compact 12.5" O.D. Torrington Mill Type Bearing, designed by Torrington's Bantam Bearings Division, provides anti-friction operation for the work rolls of a new design axle-type rolling mill in the steel industry.

ARMY E NAVY

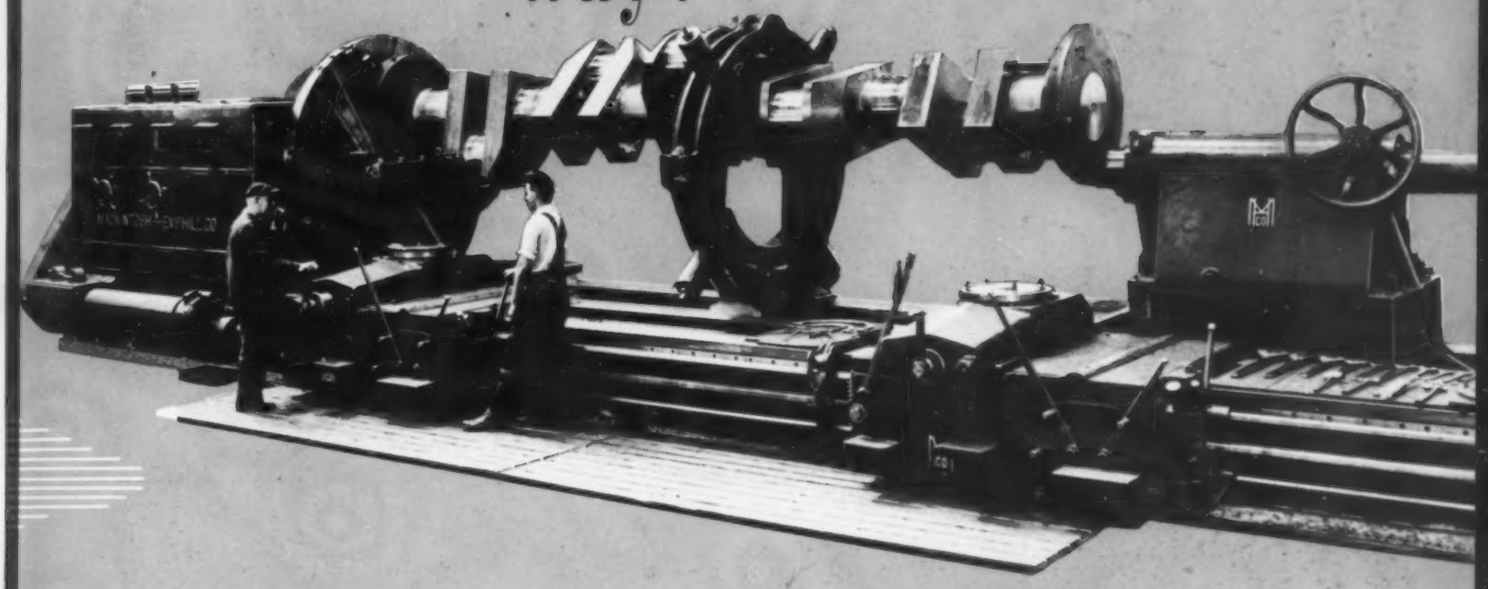
TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

Have you thought about your profits this way?

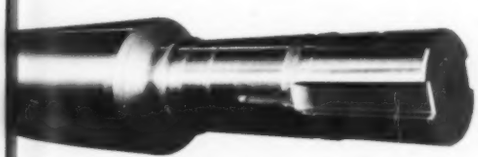


America's enormous wartime increase in production efficiency has now become an industrial habit. It sets a new and much faster tempo for tomorrow's business battles. It means that your profits and place in post-war competition will be determined, to a greater extent than ever before, by the economical productiveness of your heavy duty equipment.

Now, is the time to prune your costs and Mackintosh-Hemphill can help you do it. In their sphere of manufacturing, metallurgy and engineering they are one of the world's leading sources of industrial developments. For instance, M-H double duty, heavy engine lathes will perform all conventional and many special turning and boring operations with remarkable efficiency. When rough cutting, their rate of stock removal on many types of work, is more than 50% faster than on regulation heavy duty lathes—and this without vibration or excessive strain on any part of the machine. Mackintosh-Hemphill offers you an efficient approach to all heavy duty equipment problems. Their advanced industrial thinking may be your answer to today's production schedule and tomorrow's market price.

MACKINTOSH-HEMPHILL COMPANY

Pittsburgh and Midland, Pennsylvania



Makers of the rolls with the red wabblers

OTHER PRODUCTS:—Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports.

Mackintosh-Hemphill has been the originator of practically every major roll development . . . Their Nironite D Cold Mill Rolls are usable down to scrap size without the necessity of further heat treatment and resultant refinishing.

Readily fabricated rack handles forgings in 15% sulfuric acid at 200° F.

Ring forgings of AMS No. 6253 aircraft quality steel loaded in pickling rack fabricated from standard mill forms of Monel.

This rack has special significance to every user of pickling equipment.

It was fabricated from *standard mill forms* of Monel.

Designed and constructed in the plant of the M. W. Kellogg Co., Jersey City, N. J., the rack operates in a 15% concentration of sulfuric acid held at 200° F.

The circular frame consists of hot-rolled Monel flat bar, 4 inches wide and ¾ of an inch thick. For the hanger frame, 1¼″ diameter Monel rods were employed. The lattice bottom was constructed of ⅜″ x 2″ Monel flat bars, riveted and welded at intersections.

Tough, strong and corrosion resistant, Monel is the logical metal for pickling equipment. It is readily fabricated and welded. It retains its high strength and resistance to corrosion, assures heavier pay-loads, more continuous operation and less time out for repairs.

Information of value to those charged with maintaining pickling room efficiency is contained in Bulletin T-3, "Monel in Sulfuric Acid." We'll be glad to mail you a copy upon request.

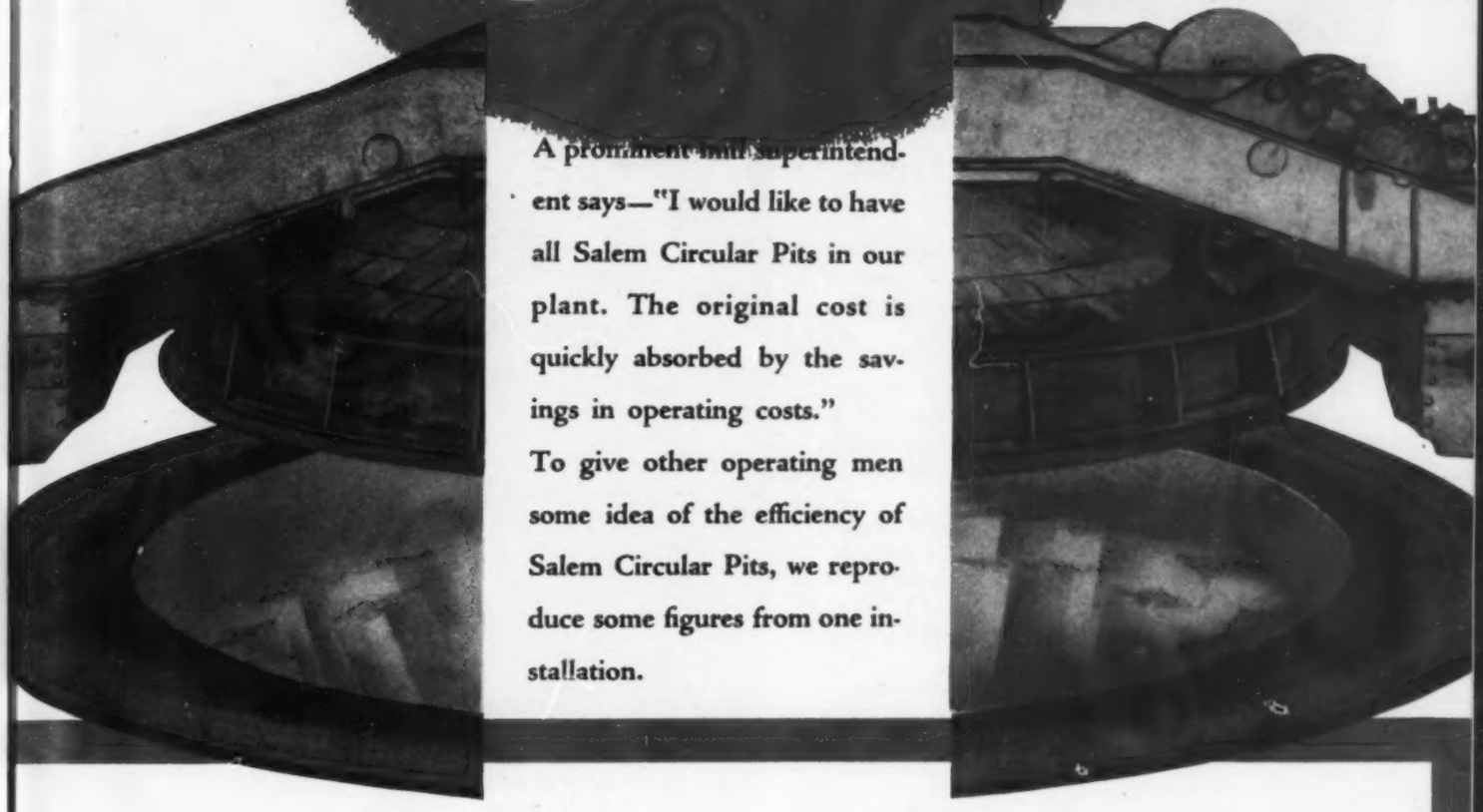
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

NICKEL INCo **ALLOYS**

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • Sheet... Strip... Rod... Tubing... Wire... Castings

SOME INTERESTING FIGURES ON CONDITIONING COSTS

ACTUAL OPERATING DATA ON Salem CIRCULAR SOAKING PITS



A prominent mill superintendent says—"I would like to have all Salem Circular Pits in our plant. The original cost is quickly absorbed by the savings in operating costs."

To give other operating men some idea of the efficiency of Salem Circular Pits, we reproduce some figures from one installation.

Write today for Details on the Pit Which Saves You More Money per Ton of Steel Heated.

Tons charged per pit	100 to 180 tons
Scale loss	1½% maximum
Minor repair on covers	18-24 months
Minor repair on pits	18-24 months
Average maintenance cost per ton over a 4 year period	1½ to 1¾c
Time required to condition bottom and bring pit back to temperature	1 hour average

Detailed operating costs, as applied to your plant, will be supplied upon request.

Salem has been building Circular Soaking Pits for 10 years. Sizes range from 8' to 20' diameter.

Salem Engineering Company will prepare a proposal based on your requirements.

Salem can show you how to save several cents per ton on conditioning costs.

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. · SALEM, OHIO

A·B·K

Laminated Plastic Bearings

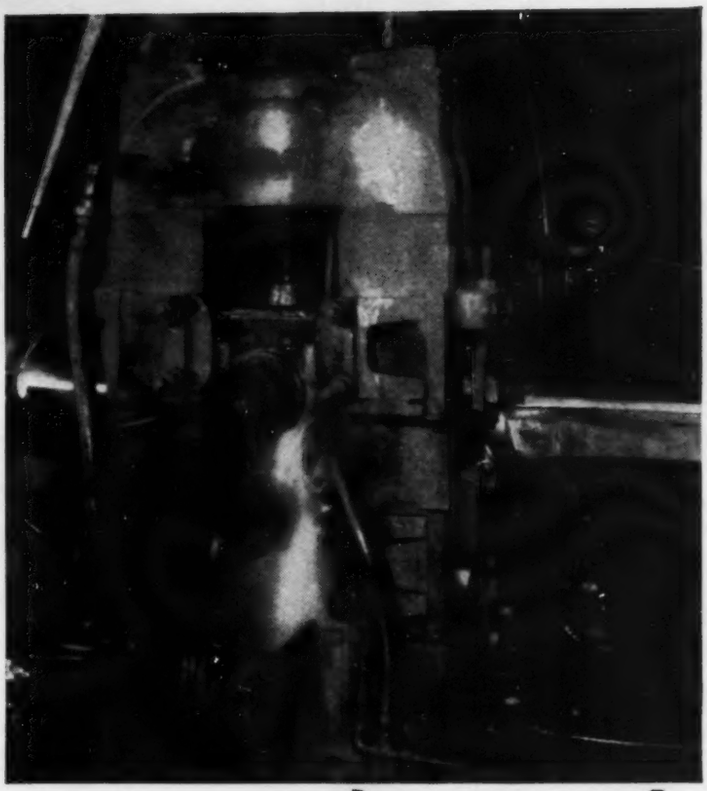
Reduce Power Costs— Increase Production

A·B·K Laminated Plastic Bearings are made to a tested formula in one of the most modern plants in America. They are furnished to size, ready to install without extra machining.

Developed by American Brakeblok engineers to provide an unusually low coefficient of friction, A·B·K Laminated Plastic Bearings have shown extensive savings in power consumption when used on rod, merchant, blooming and other steel mills.

In addition to power savings, A·B·K Bearings have provided increased production up to 20 times the tonnage as compared with metal bearings.

The research and engineering facilities that created this dependable, long lasting material are available for your individual needs. Phone, write or wire American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Michigan.

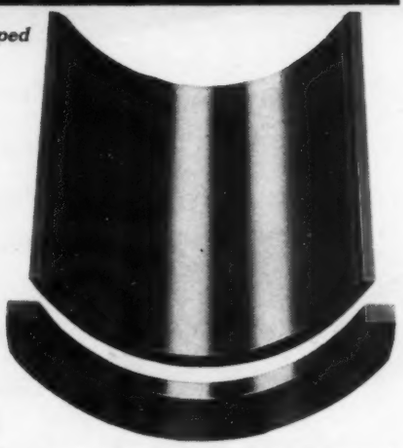


14-inch Roughing Mill equipped with A·B·K Bearings.

A·B·K Patented Reinforced Edge Slipper Bearing. Made ready to install to your blueprints.

Phantom view of A·B·K Patented Reinforced Edge Slipper Bearing.

A·B·K Laminated Plastic Roll Neck Bearing with separate thrust collar.



Industrial and Marine Uses A·B·K Laminated Plastics

- Textile Mills
- Rubber Mills
- Steel Mills
- Paper Mills
- Industrial Truck Wheels
- Pintle Bearings
- Marine Stern Tube Bearings
- Rudder Bearings
- Engine Mounts
- Pump Valve Discs

American Brakeblok

TRADE MARK REG. U.S. PAT. OFF.

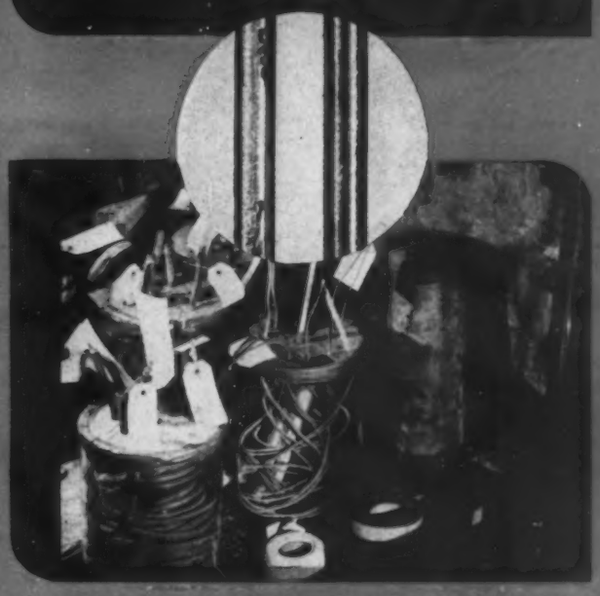
DIVISION OF AMERICAN Brake Shoe COMPANY

OKOLOY

...an Okonite "First" for the Navy that will benefit You

• Before coating conductors with Okoloy, the annealed copper wire is electrolytically cleaned, thoroughly scrubbed, wiped, rinsed and wiped again.

• After cleaning and coating with flux, the wire passes through the Okoloy bath where, under carefully controlled temperature, the corrosion-resistant coating is applied. Heat-resistant, fiber glass wipers smooth the coating as the wire emerges from the tank and a final quenching completes the process.



• Comparative tap water immersion test on Okoloy and tin-coated, rubber-insulated wires (above). Note the corrosion and almost total loss of tin and pitting of enlarged photo of copper conductor shown in circle. Note also that Okoloy (right) is unaffected by the same exposure.

When the war came, the Navy was forced to discontinue the tin coating they always used on the conductors of rubber-insulated wires and cables.

Over 16 years ago, Okonite chemists and research engineers, dissatisfied with the then standard practice of tinning, because it often led to failure and premature destruction of expensive cables, developed and perfected Okoloy, a lead alloy coating that outlasts tinning at least 2 to 1.

Thus Okoloy, in service on industrial cables for many years, was ready when the Navy could no longer get tin.

If *you* want your electrical cables to have conductors that resist corrosion, prevent contamination of the insulation, and stay clean for easy splicing and termination, specify Okoloy long-lived conductor coatings. Write for Bulletin OK-2019 if you would like additional data. The Okonite Company, Passaic, New Jersey.

OKONITE

INSULATED WIRES AND CABLES

3806

IS YOUR PROBLEM ONE OF MAINTAINING PRODUCTION WITH LESS *Manpower?*

Proper use of mechanized material handling equipment can help offset manpower losses. Most plants find that a Baker Truck—with a single operator, will release a number of men for other duties. Faster handling of materials speeds production in other ways, too. If you have a manpower problem, the actual case histories below may offer a solution. Many more are reported in the New Baker Catalog.

★ ★ ★ ★ ★

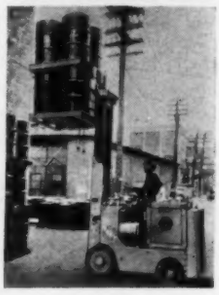
One company writes "With our Baker Truck we increased storage area by stacking, releasing valuable space for production . . . We were able to save the labor of six men and speed movement from receiving platform to storage—saving elevator tie-up . . . we removed the ever-present danger of strains and hernias." (See illustration at left.)

Records show that one of the first ram trucks, introduced by Baker in 1922, realized savings of 35 man hours per carloading for a steel mill. Today ram trucks are standard equipment for handling coiled materials. Illustration at right shows one of a fleet of Baker Trucks in the world's largest, most modern stainless mill.

"Womanpower" has replaced lost manpower and helped maintain production in thousands of plants. Because of their extreme ease of handling, Baker Trucks are ideal for women operators. Illustration at left shows a truck in service at a plant of the world's largest aluminum producer.

A fleet of eight Baker Trucks keeps the plant of a large domestic range manufacturer—now engaged in turning out war goods—at top production. Trucks service machines with materials to keep them running without interruption. Faster movement of parts and products in plant, warehouse and on loading platforms has cut handling costs 75%. (See illustration at right.)

An important factor in maintaining production in a large aircraft plant is the minimizing of "down-time" of large presses. The Baker Die Handling Hy-Lift Truck makes quick work of removing or placing dies in position—and simplifies their storage. (See illustration at left.) This plant also uses Baker Crane Trucks for speeding operations on the assembly line.



The problem of handling efficiently the wide variety of materials at a large chemical manufacturing plant is solved by a fleet of Baker Fork Trucks. (See illustration at right.) In carloading operations alone, on a conservative estimate, one Baker Truck replaces seven men with hand trucks.

★ ★ ★ ★ ★

If you have a material handling problem and are looking for the best answer, the Baker Material Handling Engineer nearest you will gladly help you. Or write us direct.

BAKER INDUSTRIAL TRUCK DIVISION *of The Baker-Raulang Co.*
2166 West 25th Street • Cleveland, Ohio
In Canada: Railway and Power Engineering Corporation, Ltd.

LOOK AT THESE BAKER CONSTRUCTION FEATURES BEFORE YOU BUY AN INDUSTRIAL TRUCK

Every part of every Baker Truck has been especially designed for its specific function. Many Baker Features are exclusive. Others, pioneered by Baker, are now standard in the industry.

BAKER HYDRAULIC LIFT

Efficient, trouble-free hydraulic lift provides power lifting and gravity lowering under absolute control at all times. Motor-driven gear pump supplies oil under pressure to cylinders with speed controlled by metering valves. Movement of hydraulic jack is compounded through a pair of chains and sprockets.

BAKER SAFETY INTERLOCK

Contactor interlocked with controller and brake, makes and breaks travel motor circuit, confining arcing to contactor thus minimizing burning of controller contacts. Circuit can be closed only with brake released and controller set for first speed, eliminating starting without operator in position. Raising of pedal automatically applies brake and stops truck, a safety feature when truck stops on a grade or when operator leaves his position.

BAKER POWER AXLE

Exclusive Baker design provides most efficient operation, low maintenance and long life. Hardened alloy steels are used in all vital parts. All bearings, axle shafts, and universal joints are dust protected.

WRITE FOR YOUR COPY

Plant and production managers, traffic managers, superintendents, purchasing agents and any others concerned with material handling will find the new Baker Catalog No. 52 a valuable reference.

Baker INDUSTRIAL TRUCKS

Made to be buried *alive*

Just tonnage—but it forms the warp and woof of concrete dams and bridges and buildings erected to stand for all time.

Made to be buried alive, the concrete bar need not be a fussy job. But it can become profitable tonnage on a Morgan Mill designed and built to swing quickly from the rolling of accurate wire rod to merchant shapes . . .

Such mills can be available for your postwar business, if you plan *now*.

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS

R-127

PLAN NOW WITH **MORGAN**

ENGINEERS AND BUILDERS OF ROLLING MILLS • WIRE MILLS
GAS PRODUCER MACHINES • REGENERATIVE FURNACE CONTROL

N·B·M SILVER BABBITT STANDS UP UNDER HIGH SPEED—HEAVY LOAD
SILVER BABBITT NO. 397
NATIONAL BEARING METALS CORP
ST. LOUIS · MO.
N·B·M

Over two years of gruelling wartime service have proved N-B-M Silver Babbitt equal to tin-base babbitts in: Anti-Frictional Qualities • Ease of Bonding • Embedability • Resistance to Squeezing Out and Corrosion • Retention of Hardness at High Temperatures.

No matter how high the speed, how heavy the load, N-B-M Silver Babbitt will protect your shafts and bearings. Specify it next time and forget the tin shortage. May we send you our engineering briefs?

N·B·M

NATIONAL BEARING
METALS CORPORATION

ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

UNITED ROLLS

All types, grades and designs for every Hot or Cold Rolling requirement

Finished Complete . . . Necked and Rough Turned, or in the Rough

"UNEFCO" GRAIN AND CHILL
"The Roll With the Green Wabbler"

NICKEL CHILL	CARBON STEEL
REGULAR CHILL	"H.D." IRON
SPECIAL PROCESS	UNIDENSE
MOLYBDENUM CHILL	ADAMITE
CONDENSED SAND IRON	SUPER-X
"UNEFCO" GRAIN AND CHILL	VAN-X
SPECIAL ALLOY STEEL	"UX" "D.U."

From the above famous UNITED ROLL LINE, comprising *15 principal classifications* and *more than 150 distinct variations of composition,* we can furnish the exact combination of characteristics for your specific need, whether you roll *steel, non-ferrous metals, rubber, synthetic resins or other materials.*

UNITED ROLLS are the product of constant metallurgical research, advanced technological skill, modern production facilities and more than 40 years experience in roll design and manufacture. Their pre-eminent position in the rolling industry throughout the world is your assurance of complete satisfaction.

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Davy and United Engineering Company, Ltd., Sheffield, England · Dominion Engineering Works, Ltd., Montreal, P. Q. Canada.

UNEFCO REG. U.S. PAT. OFF.

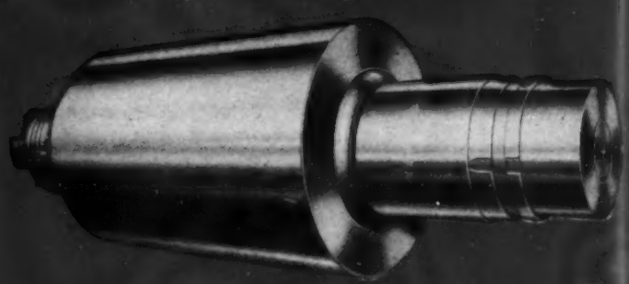
** The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

In ALL Rolling Mills...

Ohio Rolls

"Bears for Punishment!"

All-out steel production demands rolls that can stand brutal punishment. Ohio Rolls are showing their ability to "take it" in all Rolling Mills . . . every minute of the day.



SELECT FROM THESE 9 TYPES OF OHIO STEEL AND IRON ROLLS

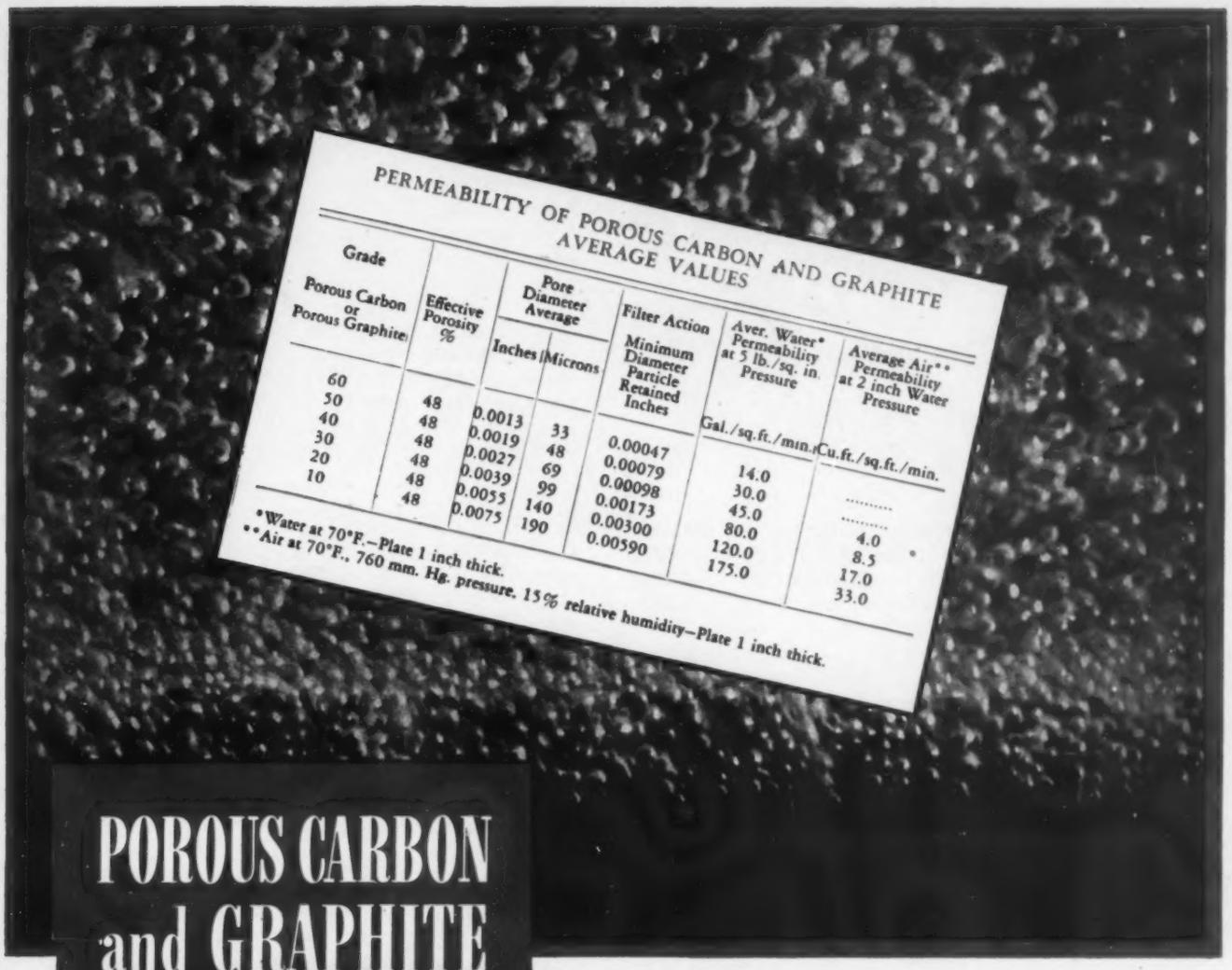
Carbon Steel Rolls	Ohioloy Rolls
Ohioloy "K" Rolls	HOLL-O-CAST Rolls
Chilled Iron Rolls	Denso Iron Rolls
Nickel Grain Rolls	Hi-nickel Grain Rolls
	Flintuff Rolls

The Ohio Steel Foundry Co.

LIMA & SPRINGFIELD, OHIO

ENGINEERS
FOUNDERS
MACHINISTS

Free enterprise is the only way to constantly higher American living standards.



PERMEABILITY OF POROUS CARBON AND GRAPHITE
AVERAGE VALUES

Grade Porous Carbon or Porous Graphite	Effective Porosity %	Pore Diameter Average Inches	Pore Diameter Average Microns	Filter Action Minimum Diameter Particle Retained Inches	Aver. Water* Permeability at 5 lb./sq. in. Pressure Gal./sq.ft./min.	Average Air** Permeability at 2 inch Water Pressure Cu.ft./sq.ft./min.
60	48	0.0013	33	0.00047	14.0	.....
50	48	0.0019	48	0.00079	30.0	.....
40	48	0.0027	69	0.00098	45.0	4.0
30	48	0.0039	99	0.00173	80.0	8.5
20	48	0.0055	140	0.00300	120.0	17.0
10	48	0.0075	190	0.00590	175.0	33.0

*Water at 70°F.—Plate 1 inch thick.
**Air at 70°F., 760 mm. Hg. pressure. 15% relative humidity—Plate 1 inch thick.

POROUS CARBON and GRAPHITE

For Filtration and Gas Dispersion in the Chemical and Metallurgical Industries

AS PLATES, open and blind-end tubes, and rods, "National" porous carbon and graphite are ideal materials for the diffusion of gases in liquids and for the aeration and filtration of liquids, particularly those of highly corrosive character.

They are inert to practically all acids, alkalies, and other solutions and are especially useful for the filtration of *molten salts, alkalies,* and *fluorides.* A special porous carbon is available for use in *caustic* filtration.

High and uniform permeability, and small pore size, make these materials unusually effective for gas dispersion . . . and ideal for steam spargers for the heating of corrosive liquids with steam. They dissipate steam in minute bubbles, with resultant high heat absorption by the liquid and freedom from bumping. And they are not subject to fracture and spalling from thermal shock.

Available in six grades and a wide variety of standard and special sizes, porous carbon and graphite plates, tubes and rods may be easily machined and fabricated into virtually any type of apparatus. For complete details, write to our nearest Division Office.

Keep Your Eye on the Infantry . . .
the Doughboy Does It!

The registered trade-mark "National" distinguishes products of National Carbon Company, Inc.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Crops *and* Shorts

THE plan of Secretary Morganthau for making Germany an agrarian nation in the postwar period has been widely attacked by engineers and technicians who instead propose that we remove Germany's ability to make war by eliminating her synthetic oil capacity and aircraft plants, 75 per cent of her synthetic nitrogen capacity, and 50 per cent of her steel capacity, while holding down her imports of steel-making materials and aluminum. Might be all right but we can't forget the German who worked in a bicycle plant and who stole one of each part so that he might ride to work — but everytime he assembled it, all he got was a machine gun.

▲

GOOD postwar business for equipment manufacturers seems a certainty if projects now being considered develop into realities. Much activity is to be noted in plans for rolling mills, forge shops, etc., outside of the United States. Such units seem to be principally of the small, simple types for relatively low tonnages but the total volume should be appreciable. China and South America appear in most of these plans.

▲

WPB has advised the Toy Manufacturers Industry Advisory Committee that various materials, such as lumber, textiles, rubber, leather and paperboard, may remain critical and be difficult to obtain even after the defeat of Germany. Looks like another tough year for yo-yos.

▲

SPEAKING of shortages, the current cigarette situation has introduced the youngsters to a number of brands of which they had never heard — as well as reintroducing the oldsters. Instead of "cigarettes for soldiers," the boys in the camps will be starting a "cigarettes for the civilians" movement to maintain home front morale.

▲

A BACKLOG of over 10 billion dollars for construction projects awaits the relaxation of government controls and the availability of manpower and building materials, according to fact-finding F. W. Dodge Corporation.

ACCORDING to the New York Trust Company, the annual steel capacity of the principal steel manufacturing countries of the world stood at 207,400,000 tons last year, disregarding war damage. This is 23,000,000 tons above the peacetime year of 1938. American steel executives look for steel exports to be 7,000,000-8,000,000 tons per year in the first two postwar years, then to fall through the next several years to 3,000,000-4,000,000 tons annually.

▲

ONE more indication of the expansion of steel producers into further finishing operations is the extent to which the steel barrel and drum industry has been taken over by the steel companies. Approximately 87 per cent of the capacity is now affiliated with one or another of seven major steel producers.

▲

BITUMINOUS coal production continues to run about 6 per cent ahead of last year but consumption is also increasing and stocks on hand are considerably under those of a year ago. Latest reports show by-product coke plants to have an average of 23 days' supply on hand. This is somewhat below railroads, utilities and other industries which have 43-77 days' supply on hand.

▲

NOW that Frank Sinatra and Orson Welles have come out for President Roosevelt, the Republicans will probably have to counter by persuading Charley McCarthy to back them.

—

ALUMINUM box cars to be supplied by Reynolds Metal Company will contain 29,000 lb of steel and 7500 lb of high strength aluminum alloy. Total weight saved over steel cars is about 10,000 lb each.

▲

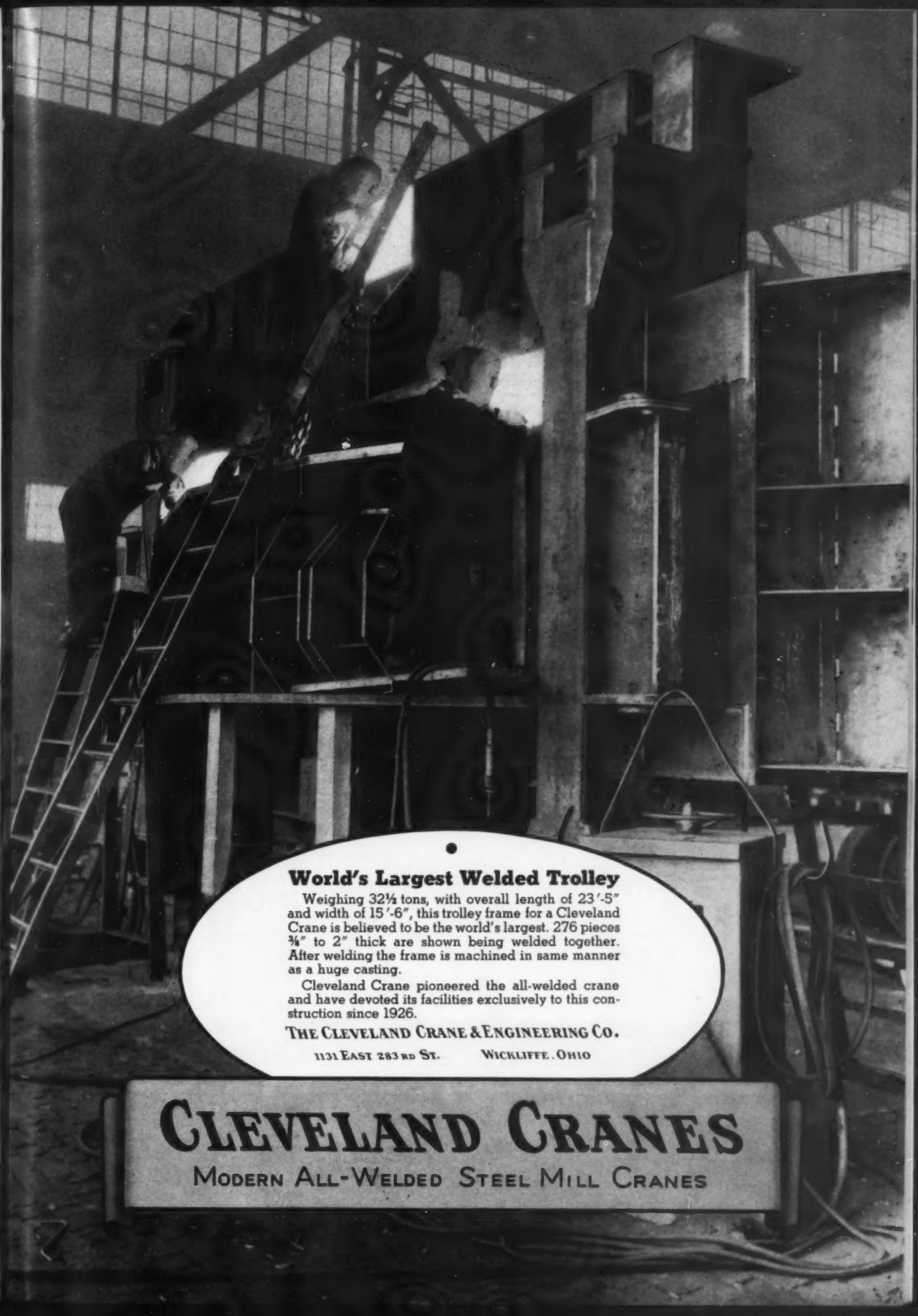
INTEREST continues to run high in technical meetings. The Annual Engineering Conference of the Association of Iron and Steel Engineers held last month in Pittsburgh had a total attendance of 2200, a new record for these meetings held without the Iron and Steel Exposition. Likewise, the second meeting of the A. I. M. E. Electric Furnace Committee held in Pittsburgh October 5-6 had a registration of 547 as compared to 425 last year.

▲

APPRAISERS are now in the process of determining reproduction costs of DPC plants without the excessive overtime payments, excessive material costs and special war costs which entered so heavily into the actual construction. Approximately two-thirds of the operators of these plants have indicated their desire to buy or lease the properties.

▲

STEEL production for the first 9 months of 1944 totals 67,199,467 net tons of ingots, a new record almost one million tons above the same period of last year. Whether record production will continue throughout the year or whether cut-backs will bring the year's production below that of last year remains to be seen.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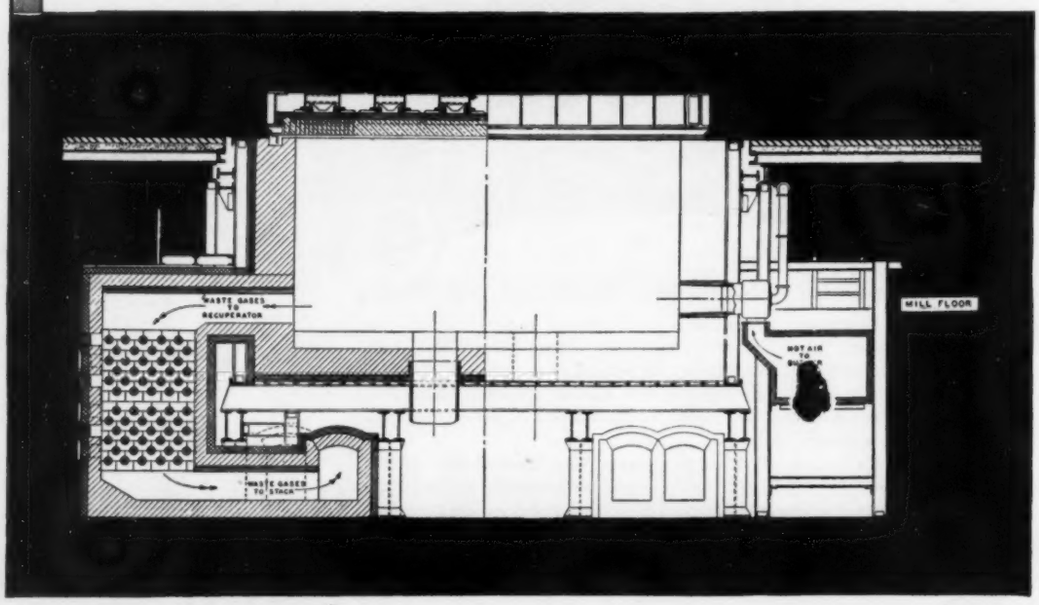

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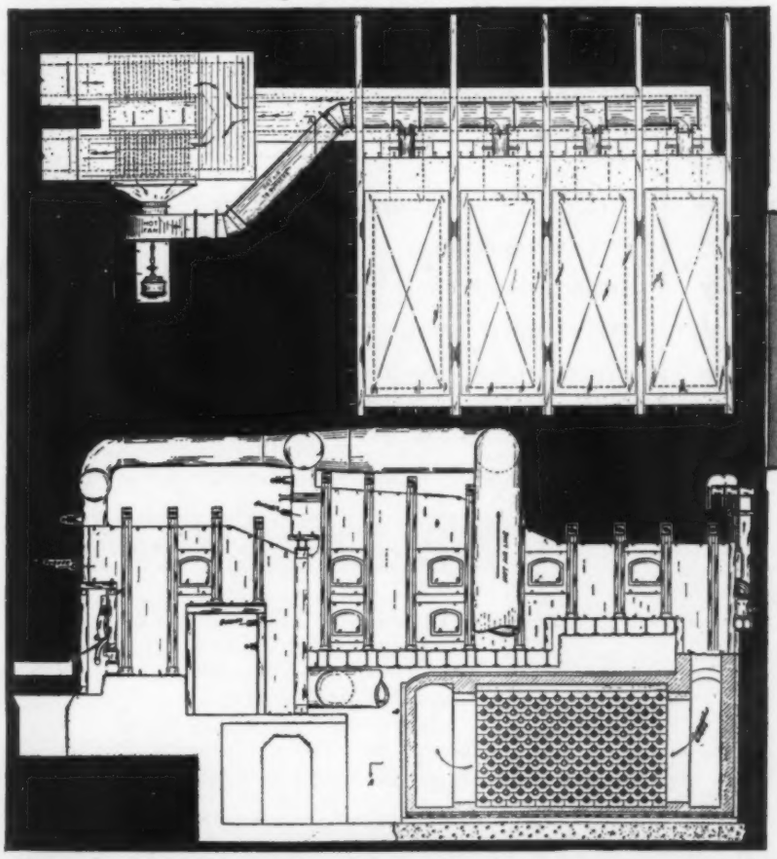

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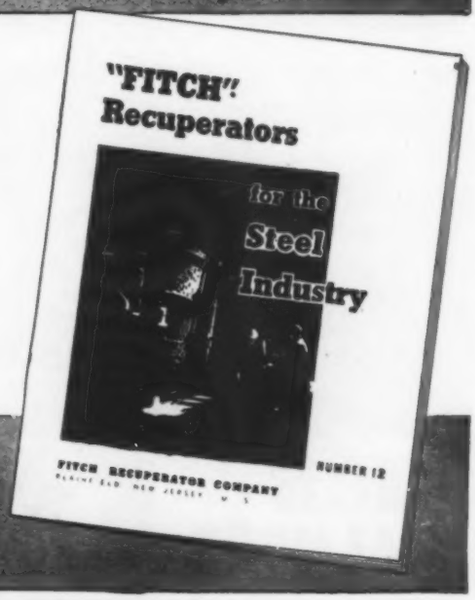

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In This Issue

Effects of Heating and Rolling on Blooms, Billets and Bars — by Robert Sergeson, Plant Metallurgist, Park Works, Crucible Steel Company of America, Pittsburgh, Pennsylvania.. 35

Discussion: Effects of Heating and Rolling on Blooms, Billets and Bars — presented by C. J. Wyrough, Robert Sergeson, R. I. Gumaer, R. O. Thomas, Alex Montgomery, Jr., V. J. Snodgrass and Paul Lindberg..... 40

Effects of Heating and Rolling in the Strip Mill — by W. H. Richey, Strip Mill Superintendent, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania..... 42

Discussion: Effects of Heating and Rolling in the Strip Mill — presented by Philip Schane, Jr., P. S. Kingsley, W. H. Richey, W. F. McGarrity and E. L. Robinson..... 44

Gas Products and Producer Gas — by L. L. Swift, Engineer, The Wellman Engineering Company, Cleveland, Ohio..... 45

New District Chairmen, A. I. S. E...... 50

Republic Builds for D. P. C. — by T. J. Ess..... R-1

Methods and Equipment for Induction Heating — by C. C. Levy, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania..... 51

The Merchant Mills at Great Lakes Steel Corporation:

The Mills — by Charles Moon, Superintendent of Merchant Mills, Great Lakes Steel Corporation, Ecorse, Michigan 59

Roll Designing — by Thomas Smith, Roll Designer, Great Lakes Steel Corporation, Ecorse, Michigan..... 61

Discussion: The Merchant Mills at Great Lakes Steel Corporation — presented by J. C. Patton, Jr., Thomas Smith, L. R. Milburn, W. J. Evans, D. J. Rosencrans, C. E. S. Eddie, H. C. Hoeft, W. H. Clark, R. E. Walsh, J. A. Clauss and John Solomon..... 63

News Supplement..... 73

Equipment..... 73

Literature..... 80

Personnel..... 85

A. I. S. E. District Section Meetings..... 87

Index to Advertisers..... 97

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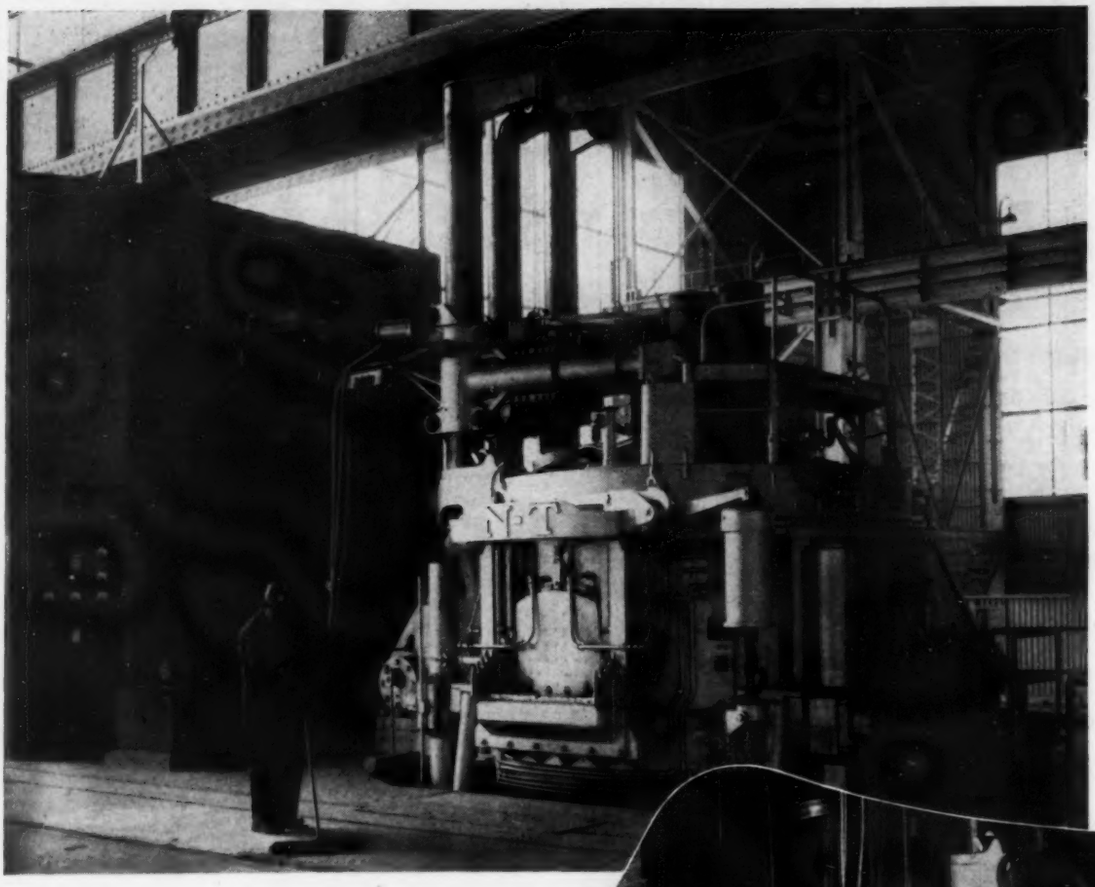

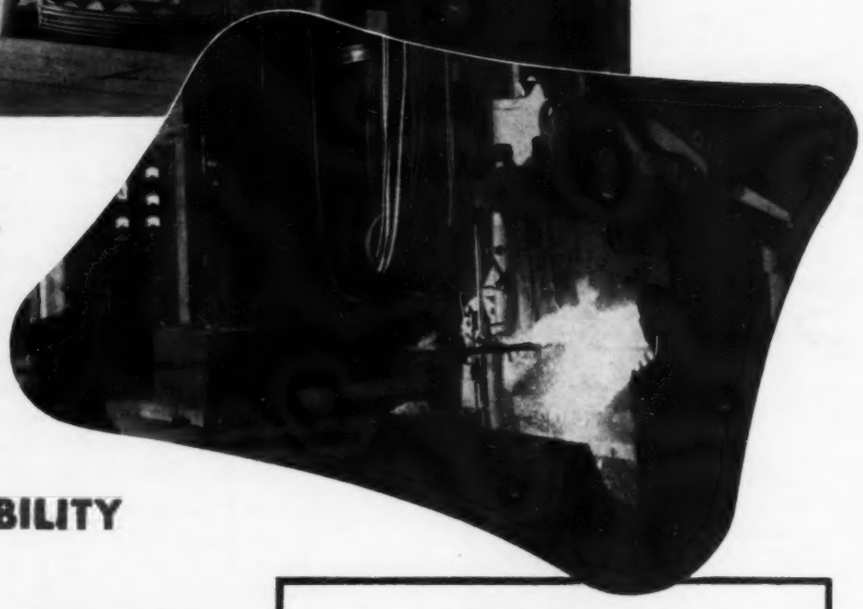

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EFFECTS OF *Heating and Rolling* ON BLOOMS, BILLETS AND BARS

. . . . discussing many of the factors which play an important part in the quality and structure of semi-finished steel . . . .

by Robert Sergeson

PLANT METALLURGIST, PARK WORKS

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▲ IN the production of blooms, billets and bars, heating and rolling play very important parts in assuring steel quality and desired structures. The American Iron and Steel Institute manual classifies blooms and billets as follows:

Bloom — 36 square inches minimum cross-sectional area (approximately equal in width and thickness).

Billet — 1½ in. minimum cross-sectional dimension, and 36 square inches maximum cross-sectional area.

A bar is the product of rolling of a bloom or billet.

If we are to have quality blooms, billets and bars, we must of course start with an ingot relatively free from defects. Therefore, let us first briefly consider the ingot.

In general use, there are two types of ingots, namely the big-end-up and the big-end-down. The former is used for quality carbon steels, alloy steels and special steels, while the latter is used for soft carbon steels. The size and shape of the ingot may vary considerably, depending upon the grade of steel and whether it is top or bottom poured. Many grades can be successfully cast into various size moulds. In such cases, the size and length of the bar ordered determines the ingot size. This situation occurs when large size rounds are ordered in long lengths. For example, one ingot may produce two multiples and another produce two and a half multiples. In such case, it is obvious that the former ingot must be selected.

Presented before A. I. S. E. Pittsburgh District Section Meeting, February 7, 1944.

In an endeavor to discuss this subject more clearly, I have divided the various grades of steel into six groups. Each of these groups requires a somewhat different procedure in their processing. Table I shows this grouping.

STRIPPING OF INGOTS

Most of these grades are stripped from the ingot mould while the ingot is red hot. For example, an ingot

TABLE I

1. Low carbon steels and irons.
   - A. Automotive sheet steel, boiler plate, melting bar.
   - B. Armco ingot iron, Toncan ingot iron.
2. Constructional steels.
   - A. SAE, NE, AISI carburizing and medium carbon steels.
   - B. High sulphur machinery steels.
   - C. Nitralloy.
3. High carbon bearing steels and carbon tool steels.
4. Alloy tool steels.
   - A. Low alloy 1-8% total alloy.
   - B. Intermediate alloy die steels (8-18% total alloy).
   - C. High speed steel.
5. Stainless steels.
   - A. 18-8 Cr, 8 Ni (Ti — Cb — Mo — Si).
   - B. Chrome steels (10-28%) (with and without nitrogen).
   - C. Complex highly alloyed (25 Cr 20 Ni) NCT No. 3, etc.
   - D. Valve steels — aircraft and motor valves.
6. Specialties: Invar (36% Ni), 42% Ni, soft center steel jail bar, copper, nickel or stainless clad.

Figure 1 — Two types of ingots: left, big-end-up; right, big-end-down.

weighing 7000 lb will be stripped about 3 hours after pouring. For sensitive steels it is good practice to charge ingots into a preheater within one-half hour after stripping. Other non-sensitive grades such as low carbon or 18 Cr 8 Ni stainless may be allowed to cool to room temperature before reheating without any harmful effect. After stripping the ingots are examined visually for defects.

My remarks will pertain to steel rolled from big-end-up hot-topped ingots. Figure 1 illustrates the two types of ingots previously mentioned. Typical ingot defects as indicated in Figure 2 include the following:

1. *Hanger cracks* — These start at the surface, are transverse and due to tension. They are usually due to questionable pouring practice.

2. *Fire cracks* — These are snaky and due to the use of old fire cracked molds. They are usually not detrimental.

3. *Longitudinal strain cracks* — Such usually occur in top and middle portion of the ingot. Similar to these are flute and corner cracks. Their elimination may require a change in melting practice, pouring temperature or mould design, or charging sooner into preheater or soaking pits.

4. *Pits* — Pits are usually associated with high pouring temperatures.

5. *Base cracks* — These are transverse and due to tension same as hanger cracks.

6. *Scabs and shells* — These generally occur on the butt. However, they may occur all over. They are due to splash in mould and to breaking through of the first wall of frozen metal. They are most prevalent in the stainless and nitralloy grades. T. J. Woods, of Republic Steel Corporation, presented a paper on "The Origin and Prevention of Scabs" (A.I.M.E., Cleveland, Ohio April, 1943). The summary of his paper states, "For preventing scabs use a nozzle size that will permit a filling rate rapid enough to enable the metal to overtake the shells before they become too cold and oxidized. Avoid stop pours especially near bottoms of ingots. Stool leakers, which necessitate stop pours, are frequent sources of trouble."

7. *Transverse cracks* — These may occur due to metal "boiling" or "coming up" in mold. This is due to metal not being completely killed.

8. *Transverse spring cracks* — These are due to charging a relatively cold ingot of a sensitive steel into a hot undampened soaking pit. High carbon steels are particularly sensitive.

9. *Pipe and secondary pipe* — These are probably the most well known. They are regulated by melting and pouring practice, pouring temperature, grade of steel, mold design and type of hot top or pipe eliminator.

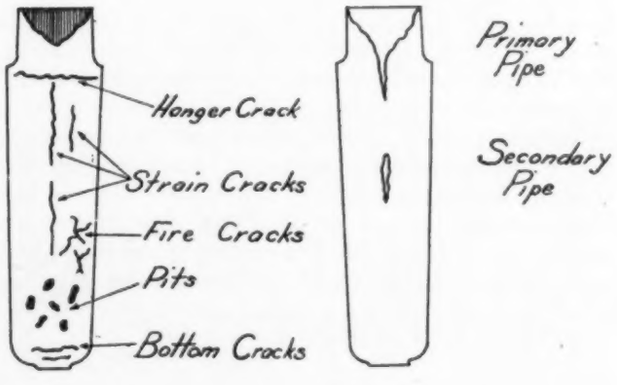
In addition to the above conditions it is necessary to know the nature of the ingot crystallization for each grade of steel. This is required in order to aid in determining the best method for reducing the ingot to bloom or slab. Figures 3, 4 and 5 illustrate ingot structures as developed by macroetching. Typical stainless steel grades have been selected as their crystallization is more pronounced than in the low alloy grades.

BLOOMS

Knowing the structural conditions of the ingot, definite heating cycles for rolling and forging are set up for each grade of steel. In general, the more sensitive grades are after stripping placed in the preheater which is approximately 1600-1800 F. The ingots are usually held in the preheater until they are uniform in temperature when they may be transferred to soaking pits and brought to rolling temperature. The soaking pit temperatures vary from 1900 F to 2400 F, depending upon the grade to be bloomed or forged.

It is essential that close control of the heating be maintained during the ingot's stay in the soaking pits.

Figure 2 — Sketch illustrating typical ingot defects.



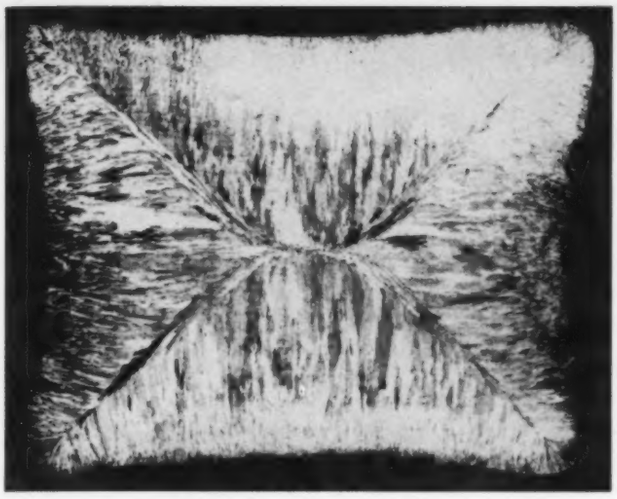
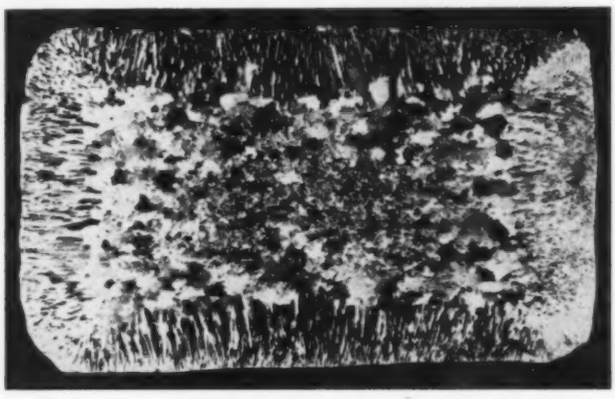


Figure 3 — Structure in a 17 in. x 20 in. ingot of 18-8 stainless steel, .07 carbon.

Figure 4 — Structure in a 10 in. x 14 in. ingot of NCT-3 stainless steel (25 per cent Cr, 20 per cent Ni).



The length of time in these pits is likewise highly important. For example, stainless steel grades require considerably longer time in pits than the low alloy steels. For the austenitic stainless grades a fair rule is to employ a heating time of one hour per inch of cross section. The following conditions should be watched:

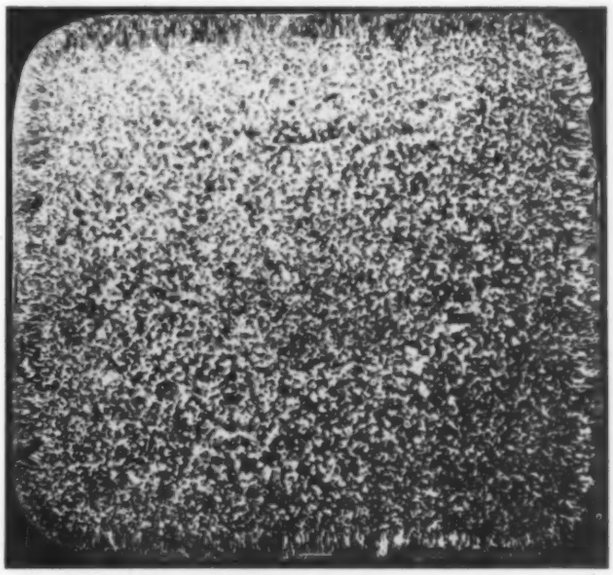
1. Prevent flame from impinging on ingots and overheating or burning of corners.
2. Do not carry too high an oxidizing atmosphere or surface will be overoxidized and become hot short. In high nickel steels, 3½ per cent nickel and 5 per cent nickel, there is a danger of nickel rich spots (50 per cent Ni) forming. This condition however, I have found only in forgings where the surfaces of billets were over-oxidized. In the last war, I am told, it occurred in large gun forgings. Also, decarburization of surface will be excessive.
3. Excessive temperature will cause grain growth which is undesirable.
4. The type of fuel used to heat soaking pits is important. A high sulphur content in fuel will produce a checked hot short surface on nickel steels.
5. Where insufficient time is employed in heating surface, ruptures result.

After rolling the blooms may be air cooled, pit cooled, ash cooled or sent to a furnace for a special cooling rate. The grade involved determines the cooling rate prescribed. When the cooling has been completed, the blooms are inspected and representative tests taken for metallurgical examination to determine the quality. Typical defects at this stage are as follows:

1. *Longitudinal cracks* — These may originate from like cracks which develop in the ingot as previously mentioned. They may also be the result of cooling strains after rolling or hammering if the subsequent cooling has been too rapid. For example, low carbon 7 per cent or 9 per cent chrome must be moved hot (800 F) into an annealing furnace if this defect is to be avoided. Billet sizes of 8 in. square or larger, of SAE 3140 or of like hardenability, may split in like manner if not stress relieved. Ash cooling or pit cooling is sufficient in many cases, but not reliable for certain grades. A 1250 F stress relieving treatment is usually employed as a safeguard.
2. *Tears* — These are the result of too heavy drafting in the rolling or to a particular grade which borders on being hot short. The latter case is exemplified by high sulphur steels where the manganese is on the low side. Tears also occur when rolling takes place in a restricted range where metal is hot short. I refer in this latter case to the dead low carbon irons such as "Armco" and "Toncan."
3. *Crow-feet* — When rolling continues, tears often develop into crow-feet.
4. *Scabs and shells* — These are carried over from the ingot. They may also be obtained in the rolling of a heavily decarburized surface which tears and folds over to form a scab.
5. *Surface seams* — These are usually shallow in nature and parallel to the direction of rolling.

Most of these defects may be removed by means of chipping, grinding or scarfing. The method employed in conditioning of the surface is dependent upon the grade of steel involved. The low carbon steel and low alloy steels of medium hardenability may be scarfed or chipped. In preparing the blooms, etc., for chipping they may be descaled by means of a torch or pickled in

Figure 5 — Structure in a 10 in. x 10 in. ingot of high nitrogen, 28 per cent Cr stainless steel.



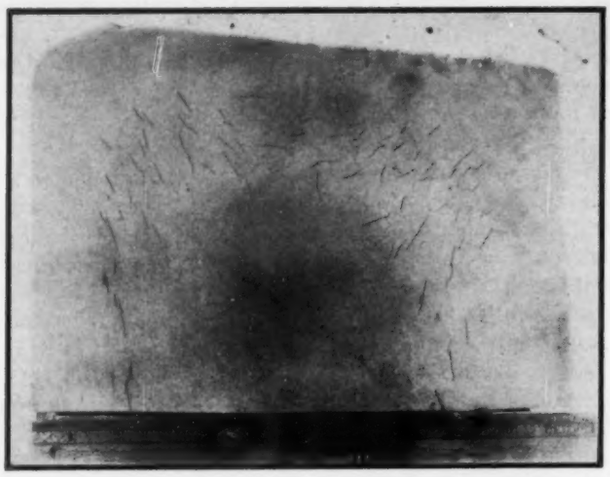


Figure 6 — Illustrating flakes in an 11 in. square of SAE-4340 steel.

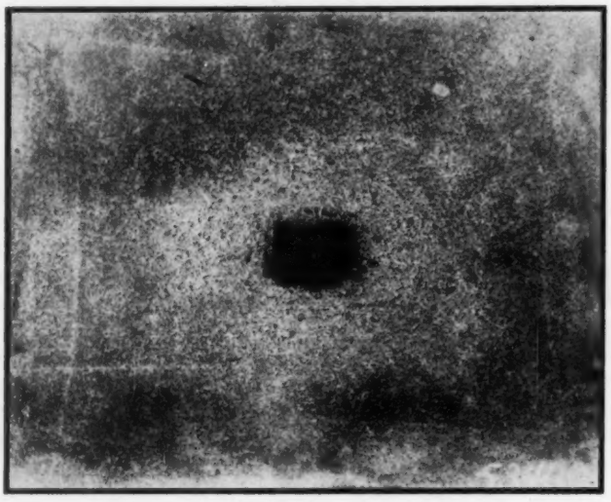
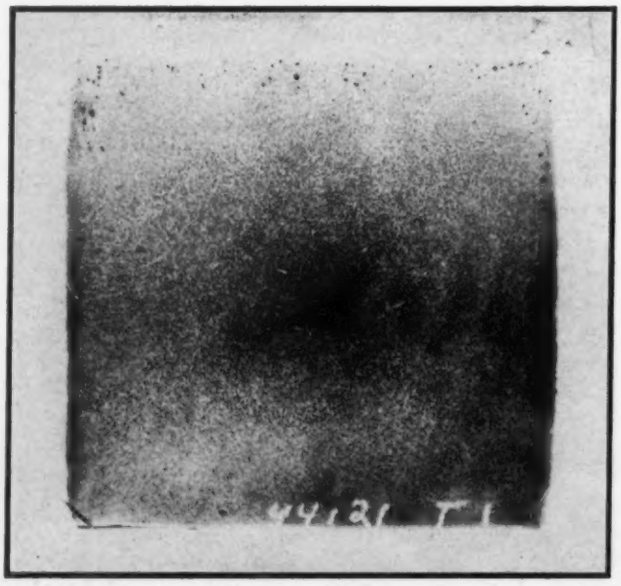


Figure 7 — Illustrating carbon segregation in the center of SAE-1060 steel.

▲

Figure 8 — Illustrating non-metallic segregation in 18-8-Ti stainless steel.



7-10 per cent sulphuric acid which brings out the defects more clearly. Where chipping is deep it must be well flared to prevent folds or seams from forming in subsequent rolling.

Grinding is the method employed for the conditioning of stainless and many other grades where the entire surface must be removed. Special wheels are required for different grades of steel to prevent the occurrence of grinding cracks.

Scarfing is the latest method of conditioning the surface and may be applied to most alloy steels below .50 carbon. The more sensitive analyses must be preheated to 400-500 F before they can be successfully scarfed. Certain grades which can be successfully scarfed in the summer without preheating must be preheated in the winter. As the surface is under strain after scarfing, no attempt should be made to pickle blooms or billets so conditioned or cracking will result. The slight carbon pick up on the surface is scaled away in the bloom or billet heating furnace, hence is not objectional. It is also practical to scarf blooms at rolling temperature and continue to roll to a smaller size billet. While this method removes light surface defects it does not remove deep tears or crow-feet.

Blooms so conditioned are rolled into billets for rerolling, or directly into bars. Tests for metallurgical requirements are taken in the billet or bloom stage. Macroetch tests are taken from representative portions of the ingot and heat. These tests are generally transverse cross sections etched in acid solution of 50:50 muriatic (hydrochloric) acid and water at approximately 160-180 F. A freshly sawed or ground surface is employed. The time of etching will vary depending upon the grade.

The following are typical conditions which may be encountered:

1. *Flakes* — This is one of the most widely known defects, but probably the least encountered. It may be prevented by the proper method of cooling after rolling or forging. Usually this is accomplished by ash cooling until temperature is below 400 F. For example, five days is a minimum time for cooling an 8 in. square. Slag may be substituted for ashes. Of recent years it has been demonstrated that if blooms and billets, etc., are allowed to cool after hot working until transformation has taken place but not below 650 F and then reheated in a furnace to or just under the Ac_1 and held until the temperature is uniform, they may be then air cooled without danger of flake. O. A. Bamberger has given very complete information on this subject in his paper "Flakes and Their Prevention", published in the November, 1943, issue of Iron and Steel Engineer.

Figure 6 illustrates flakes in SAE 4340 steel, 11 in. square.

2. *Carbon segregation* — This is illustrated in Figure 7. The dark area in the center shows segregation of carbon.

3. *Non-metallic segregation* — This defect is shown in Figure 8. The pinholes are non-metallics which have been etched out.

4. *Metallic segregation* — When steel freezes it does so by differential freezing, consequently no ingot is uniform in composition. This heterogeneity as regards composition is found to increase with the mass of the

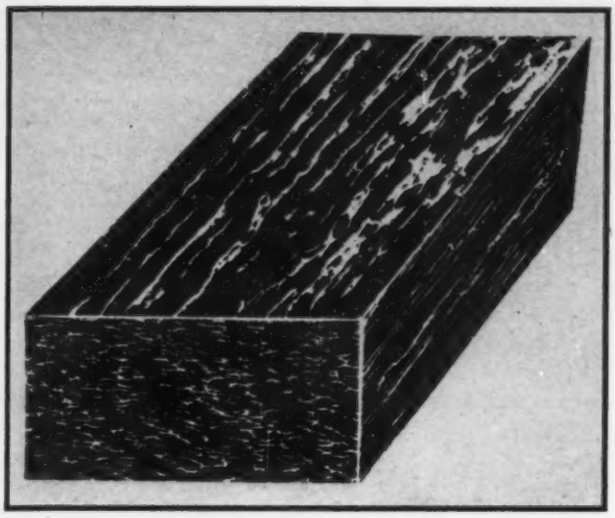


Figure 9 — Showing directional working of non-uniform cross-section (flat) of 16 Cr, 2 Ni stainless steel. Martensite and ferrite.

ingot. The ingot sizes and design used for most of our steels are such that little segregation occurs. Any one interested in the subject should review the great amount of work published by the British Iron and Steel Institute on the "Heterogeneity of Steel Ingots."

5. *Bleeding* — This is due to improper killing of heat or a mold coating containing moisture such as "green tar."

6. *Pattern* — Open steel shows a very marked pattern commonly referred to as rim and core. The rim is of lower carbon than the core. This has caused considerable study to develop the proper normalizing cycle to produce deep drawing sheet and strip.

Pattern is also found in many alloy steels, usually in the low carbon carburizing grades. In such cases, however, there is no appreciable difference in chemistry.

BARS

The same precautions hold for the heating of bloom and billets for rolling into bars as held for the heating of ingots. The finishing temperature of bars is however, of prime importance. Some factors affected by the finishing temperature are:

1. For cold shearing it is desirable to finish close to the critical point so as to produce the maximum softness and the finest grain size. This is of course, not always practical and depends upon the size being rolled. Certain grades of high hardenability must be annealed regardless of rolling procedure.
2. In high carbon bearing steels (SAE 52100) it is desirable to finish near the critical to keep the carbide network to a minimum and thus permit annealing to a proper spheroidal structure without a preliminary normalize to break up carbide network.
3. For certain low carbon alloy steels it is desired to finish well over the critical to produce a coarse grain and to cool protected from drafts to regulate the hardness. This procedure insures good machinability in the customer's plants.
4. Stainless steel, 18 Cr, 8 Ni, low C, is often finished cold to develop fine grain and desired mechanical properties. In the rolling of the higher alloyed stain-

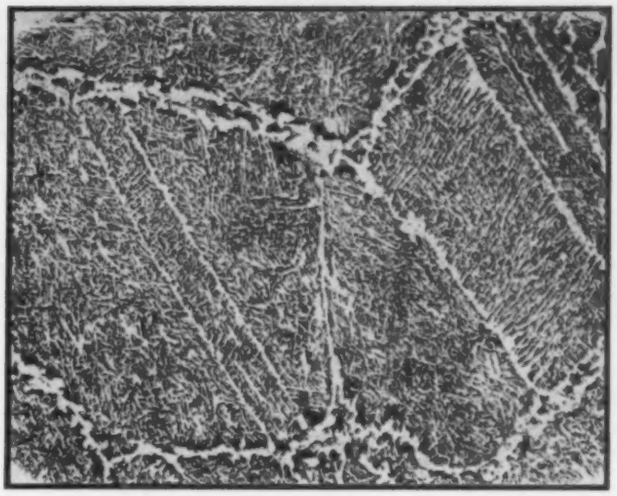


Figure 10 — Coarse grain in a Cr-Ni steel. Not desirable for cold shearing.

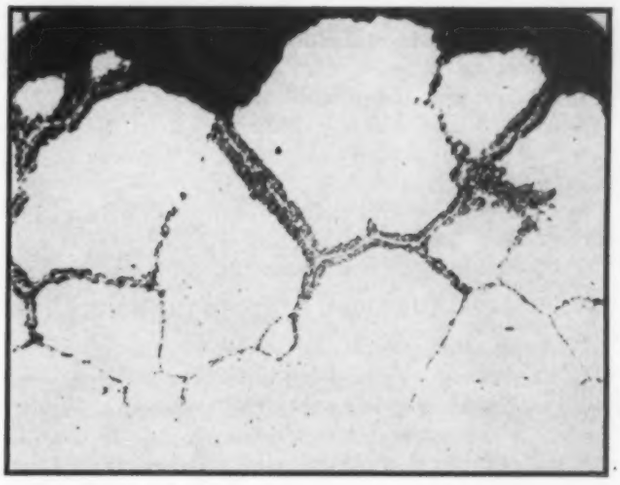
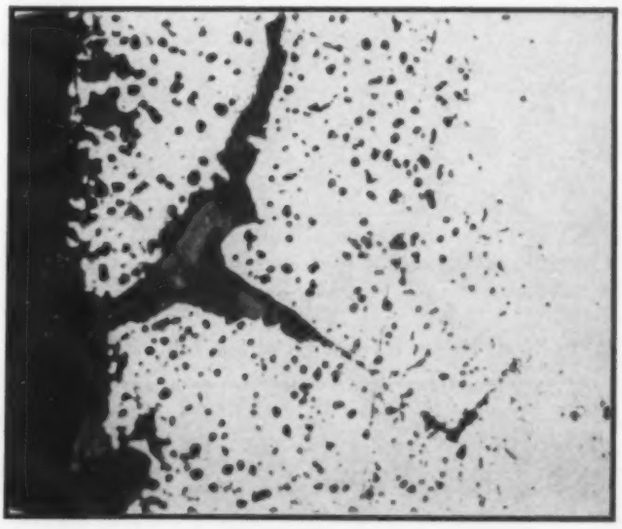


Figure 11 — Illustrating the burning of grain boundaries.

▲

Figure 12 — Dissolved and precipitated oxides from overheating nitralloy 135 modified (500 X).



less grades into squares, care must be taken to carry them in ovals until the finishing pass if checked corners are to be avoided.

5. Means of cleaning scale from billets during rolling, whether by high pressure water or wire brushes, is important if we are to prevent rolled-in-scale. The pitted area caused by rolled-in-scale acts as a focal point for fatigue failure.

I will review some of the defects which are found in the manufacture of steel bars and will distinguish between those representing a metallurgical problem and those of a mechanical problem.

MECHANICAL DEFECTS ON BARS

1. *Scratches* — These are generally caused by a small scab or foreign body which lodges against the wall of the guide. This obstruction in the guide scratches the plastic hot bar as it passes. Guide scratches generally run the full length of the bar and depending upon the size of the obstruction are of various depths and widths.

2. *Overfills* — These are caused by excessive stock on the oval. This excessive stock squeezes through the sides in the finishing pass and appears on the finished bar as a rib along the sides of the round.

3. *Diamond shape* — This defect is caused by improper alignment of top and bottom rolls.

4. *Out-of-round and egg shape* — These defects are also caused by improper alignment of top and bottom rolls in finishing pass.

5. *Split ends* — This defect generally occurs on high carbon steel and when product is sheared too cold. The crack usually runs across the center of the bar.

METALLURGICAL DEFECTS ON BARS

1. *Ruptured surface.*

(a) This may readily occur on billets that have been overheated or burned in the furnace, causing the surface metal to become hot short.

(b) Ingot iron if rolled in its hot short range (between 1700-1500 F) will likewise rupture.

(c) Steels which have high strength at rolling temperatures must be rolled so their edges do not cool materially below body of bar, otherwise tearing or rupturing of corners will result.

(d) A two-phase metal may rupture badly in rolling. Those who are acquainted with the various stainless steels will recall the trouble encountered in the rolling of the 18-8-S Mo grade when the manganese was low (under .50) and an appreciable amount of delta iron was present.

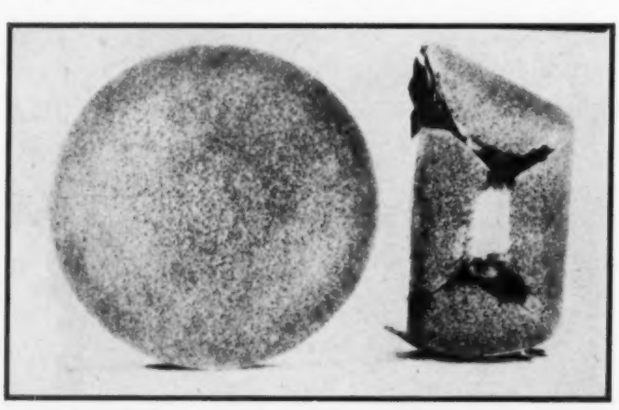


Figure 14 — Illustrating cold center forging caused ruptures.

Figure 15 — Pits are a cause of fatigue failure (SAE-4815).

Figure 13 — Delta iron in 18-8-S-Mo stainless steel, a two-phase alloy.

2. *Internal (hairline) seams* — These are due to a grouping of non-metallic inclusions. They are located by the so-called stepdown test. This test may be examined as machined, or with a slight acid dip or may be subjected to the magnaflux test.

For bearing steels, these internal seams are located and evaluated by means of a quench and fracture test.

3. *Other internal defects* — These are the same as discussed under blooms and are located by macroetching of discs.

Figures 9, 10, 11, 12, 13, 14 and 15 illustrate some of the conditions referred to in the foregoing discussion.

DISCUSSION

PRESENTED BY

C. J. WYROUGH, Superintendent, Steam Efficiency and Combustion Department, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

ROBERT SERGESON, Chief Metallurgist, Park Works, Crucible Steel Company of America, Pittsburgh, Pennsylvania.

R. I. GUMAER, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

R. O. THOMAS, Assistant to General Superintendent, Manufacturing, Carnegie-Illinois Steel Corporation, Homestead Steel Works, Munhall, Pennsylvania.

ALEX. MONTGOMERY, JR., Superintendent of Rolling, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

V. J. SNODGRASS, Metallurgist, Republic Steel Corporation, Canton, Ohio.

PAUL LINDBERG, Mill Metallurgist, Copperweld Steel Company, Warren, Ohio.

C. J. Wyrough: I would like to hear some comments on the different results obtained from the use of blast furnace gas or coke oven gas as compared with natural gas in heating operations.

Robert Sergeson: I have not had any experience with blast furnace gas but have had with producer gas with a high sulphur content. In rolling a high nickel steel we had one billet heating furnace on producer gas and one on natural gas. The surface of the small rods (approximately ½ in. rounds) rolled from these billets showed a rough pitted surface from the billets heated by the producer gas and a smooth surface from the billets heated by natural gas.

Many years ago we were forging large rounds (approximately 6 in. rounds) from 3½ per cent nickel steel (SAE 2315). The billets were heated by producer gas which resulted in a "fish scale" surface. By changing to natural gas, a smooth surface was obtained.

R. I. Gumaer: We have heated for the most part plain carbon steels with producer gas, coke oven gas and a mixture of blast furnace gas and coke oven gas. Several times we have tried to trace back defects in the finished product to the soaking pit heating, and so far we have been unable to find much difference. It seems that, if the steel is heated to a proper temperature, the fuel has little to do with it for that class of steel.

I would like to ask Mr. Sergeson if he will enlarge a little bit on this subject of burnt steels What would be considered excessive temperature sufficient to cause hot shortness in rolling, and does the furnace atmosphere play any part in that condition of hot shortness.

Robert Sergeson: I presume when you reach 2400 F you get into trouble on most steels. You can dissolve oxygen at high temperatures and definitely cause the surface of the steel to become hot short. We had a case of low carbon 2.00 per cent chrome steel about 5½ in. round which pierced satisfactorily into tubes, but which showed a bad "fish scale" condition over the outside surface. The tube company pierced some competitive steel with the same results. We attributed the condition to the highly oxidizing condition of the tube billet furnace. By cutting down on the amount of air and by sealing up many of the furnace doors, both our steel and that of the competitor were pierced without the torn fish scale outside surface.

R. O. Thomas: You mentioned steel not flaking after having been given a slow anneal. If properly slow cooled do you subscribe to the opinion that such treatment immunizes the billet from flaking when cooled following subsequent forging or rolling operations?

Robert Sergeson: There are pros and cons on that question. From my own experience I have never seen billets or bars flake due to too fast cooling after rolling, when rolled from blooms or billets which were free of flake. When large forgings are involved, I am not so sure. I have been told that flake free billets can be flaked if forgings made from them are not properly cooled.

Alex. Montgomery, Jr.: I might ask for an expression of opinion as to what effect heating would have on center segregation That seems to be a controversial issue. There is some theory that it might be helped considerably by heating.

Robert Sergeson: You can help segregation to some extent, but you have to go to a high temperature to do it, which is not practical in ordinary work. You are probably referring to banding. For a chrome-molybdenum steel, you would have to heat to 2300 F to do any good at all. With the metallic segregation you get in high tungsten steel, there it is a function of the ingot size; you dare not go too high in size. I heard a paper read by a gentleman from Republic Steel Corporation on banding. I think in that paper he covers the temperatures necessary to correct that condition. Segregation is governed in the melting practice, the pouring practice, and by the size of the molds you use.

V. J. Snodgrass: We are vitally interested in the subject of heating alloy ingots, blooms and billets as presented by Mr. Sergeson. Primarily, we are interested in the heating and rolling of the low carbon alloys, since our experience indicates these types are more sensitive in heating and present a problem of variable rolling results.

We believe we have gained some knowledge of the effect of heating rates for stainless ingots to resultant rolled quality. These rates are based on a relative increase in degrees per hour depending upon ingot size, analysis and composition of fuel. With this experience we believe some approach can be made in the heating of low carbon alloys.

However, our approach to the problem may not be the only solution. Specifically, what is the experience relative to a practical heating rate for a given ingot size of low carbon alloys to secure a quality product? What is the basic method for determining the optimim heating rate?

Robert Sergeson: With low carbon alloy steels such as SAE 4615 it is good practice to handle them much the same as the stainless steels. Bring them slowly up to temperature and hold them at rolling temperature until thoroughly uniform. If this precaution is not followed and heating is rushed, tears in the rolling will result.

Paul Lindberg: I have no comment to make on nickel, molybdenum or low carbon steel, but I would like to make a few comments on straight chrome steels and this question of longitudinal cracking and cooling; also what can be done to prevent it. When you have longitudinal cracking on a large billet section, 8 in. or over, it does not occur right away. When you lay them down in storage for six months and then put them in a furnace, that is when they crack right through the center. We have found it best to heat to about 1250 F at first to relieve the strain cracks. When it comes out of the pits, or afterwards, the scale is relatively hard and you get internal strain. You get the same thing on chrome billets. We stored a lot in our strip yard and then started to roll them and got all sorts of cracks. They were not strain relieved before we started to roll them and found it necessary to give them special treatment.

R. Sergeson: Your experience has been the same as ours. For sizes 8 in. or over, a stress relieving treatment of at least 1250 F should be given. The same condition occurs on the 4.00/6.00 chrome-molybdenum and the 12.00 per cent chrome stainless grade, only the cracking will occur sooner.

Effects OF HEATING AND ROLLING IN THE *Strip Mill*

. . . . with the many variables involved, strict control is essential to maintain high quality in flat-rolled products . . . . close cooperation is required between operating and metallurgical departments . . . .

by W. H. Richey

STRIP MILL METALLURGIST

JONES AND LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

▲ PROPER control of heating and rolling practices is essential if the high quality standards expected of strip mill products are to be maintained. Although comparable ultimate results in various mills may be obtained with widely varying practices, determined by the design and construction of the particular plant involved, the fundamental theories and practices, whether metallurgical or operating, remain the same.

Many problems requiring very close control are encountered in meeting the rigid inspection standards to which strip surface and physicals, directly influenced by grain structure, are subjected. We shall attempt to cover briefly in this paper, some of the major control problems encountered in our 96 in. hot strip mill, considering ordinary low carbon steel.

The steel is received from the blooming mill in slab form, varying in size and weight depending on the required size or weight of the finished product. A good slab surface is of the utmost importance as any serious defects will carry through to the finished product, and may mark the mill, causing roll changes and costly delays. The slabs are surface inspected, and all visible defects such as scabs, slivers, deep cracks, and tears are removed by scarfing. On some commodities, such as plates shipped with mill edges and hot rolled coils for tin plate, the slab edges are completely scarfed, thereby removing all of the original surface and tending to prevent edge cracking on the finished product.

The conditioned slabs are then charged into heating furnaces of three zone design; namely, pre-heating, heating, and soaking. The heating and soaking zones are top and bottom fired, using coke oven gas and tar as fuel. Furnace temperatures, automatically controlled and recorded, range 2250-2450 F. An oxidizing atmosphere is maintained to insure the formation of a rather heavy oxide, one that will crack or check upon contact with the air, and thus be removed readily by the scale breaker and hydraulic sprays. Proper scaling and its removal is important, acting as a safe-guard against rolled-in scale and insuring a better surface.

Since physicals are influenced by grain structure, it is most desirable that a fine, uniform, equiaxed grain be obtained off the hot mill rather than a coarse or non-uniform structure. This is especially true if the "as rolled" product is to be further heat treated by box annealing, as serious grain growth will invariably result from a non-uniform structure even at low annealing temperatures. From a metallurgical aspect, it would be comparatively simple to obtain an ideal grain structure if all steel could be rolled with a relatively high intermediate temperature, which we will refer to as that temperature between the breakdown and finishing mills, and finished above the Ac_3 point, or approxi-

Presented before A. I. S. E. Pittsburgh District Section Meeting, February 7, 1944.

mately 1600 F. This, too, has certain operating advantages, as less power is consumed and speed can be increased with resultant maximum production.

These high temperatures can be easily held on plate rollings, as the heat loss from heavy gauges is comparatively slow and surface finish is ordinarily not so restrictive. However, it is apparent that this is impossible for lighter gauges because of rapid heat loss and higher surface standards.

Rolling speed is an important factor in the control of grain structure, as it has been proven that a direct relationship exists between the two in combination with proper rolling temperatures. We have found with relatively light gauges, .075-.125 in., that a small, uniform grain can be obtained by using an intermediate temperature of 1900 F to 2000 F, a finishing temperature of 1550 F to 1600 F, and a minimum rolling speed of 1250 feet per minute. Reducing the minimum speed, even though the temperatures are maintained, will invariably result in a non-uniform structure. The same is true if intermediate temperatures drop below the minimum specified, i.e., 1900 F. This sometimes occurs when the surface will not clean up, and the roller must resort to "rocking." "Rocking," as the term implies, is running the slab back and forth on the delay table after it has been partially reduced in the roughing mills. This causes a rescale which is removed after passing through the scale breaker, and results in a cleaner surface.

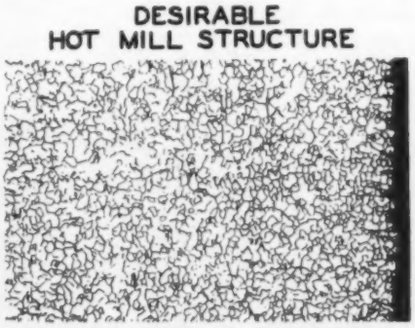
High finishing temperatures for gauges lighter than those just mentioned are limited because of the increased reduction and the rapid heat loss from the thinner section. This may be partially overcome by holding the intermediate temperatures to the high side, and by increasing the speed to 1500-1600 feet per minute, but even with this set-up there is no positive assurance of a uniform grain, especially on No. 18 gauge.

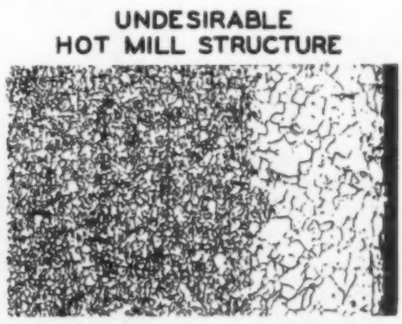
While higher rolling temperatures insure more uniform grain, they also tend to produce certain objectionable surface conditions. "Heat pattern" is one of these, and may be described as a pock-marked condition on the surface of the strip, resembling rolled-in scale. This can ordinarily be eliminated by lowering the finishing temperature, but if it becomes too bad, a roll change is the only corrective measure. Loose oxide, another surface defect especially undesirable on hot rolled sheets, is frequently encountered from finishing too hot. The use of water sprays on the run-out table offers some control for this, and results in the formation of a lighter and tighter scale, although tending to raise Rockwell hardness values slightly.

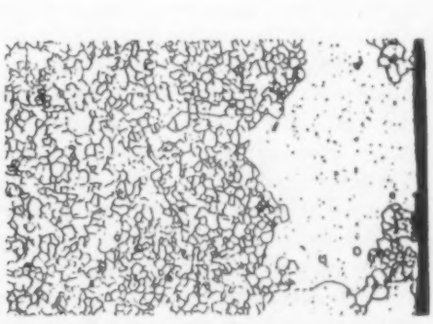
While the adverse effects of hot coiling or piling may be questioned, some slight annealing probably does occur, and the use of water permits control of these temperatures and prevents grain growth, if a critical strained condition should exist in the hot band. Quenching is particularly advantageous for material that is to be cold reduced and annealed. Pickling speeds are not penalized, and may even be increased to some extent. After annealing, the grain tends to be smaller and carbide dispersion much better, with ductility increased and bending properties greatly improved, particularly those made with the grain. This has been demonstrated conclusively on tin plate, where bends are an important part of the testing program. Quenching was also used to advantage in hot rolling steel for 50 caliber cartridge case stock. It was found that carbide size and distribution after cold reducing and spheroidized annealing was directly dependent upon carbide formation and distribution off the hot mill. Microstructures on plates piled above 1300 F showed that in pile cooling, semi-spheroidization (about 30 per cent), had taken place. The increased use of water permitted piling at temperatures below 1300 F, and resulted in an even distribution of the carbides. This structure gave small, well distributed spheroids after box annealing below the Ac_1 point. Lower temperatures were a further advantage in that the colder plate was less susceptible to scratching on the run-out table. This was an important feature, surface being a prime requisite on this product.

With the present increase in strip mill plate tonnage, direct rolling, spreading, and cross-rolling have been subjected to much discussion, and an explanation of these terms is possibly in order.

When rolling direct, the reduction on the slab is continued in the same direction as on the ingot at the blooming mill, i.e., parallel with the ingot axis, with the length of the slab becoming the length of the finished plate or hot band. In spreading, the slab is given one broad-side pass through the first roughing stand, increasing the width, then turned and passed through the remaining stands direct; in cross-rolling, the slab is turned and all reduction takes place at right







angles to the ingot axis, with the width of the slab becoming the finished length. Although our investigational work on plain carbon steel has been somewhat limited relative to these various practices, little difference in the usual physical properties has been noted between them. However, on cross-rolled plates, a slight improvement has been noted in transverse bend properties and ductility as measured by dynamic test values. Cross-rolling should minimize directional properties, although penalizing the mill by decreased production due to the necessity of using a lighter weight slab.

We believe that with the many variables involved, strict control is essential. An observer from the metallurgical department is on the mill at all times, working with the mill personnel in seeing that standard procedures are followed. Performance results are watched closely, and as conditions warrant, changes are made accordingly. High quality can be maintained in this manner and this high quality can only be achieved through close cooperation between the operating and metallurgical personnel.

DISCUSSION

PRESENTED BY

PHILIP SCHANE, JR., Chief Process Metallurgist, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

P. S. KINGSLEY, Chief Metallurgist, Follansbee Steel Corporation, Follansbee, West Virginia

W. H. RICHEY, Strip Mill Metallurgist, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

W. F. McGARRITY, Assistant Chief Metallurgist, Weirton Steel Company, Weirton, West Virginia

E. L. ROBINSON, Assistant Chief Process Metallurgist, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

Philip Schane, Jr.: The setting up of heating and rolling temperatures is very important and is generally a matter of experiments and experience. Some metallurgists use a test consisting of upsetting a series of pieces of steel at various temperatures to determine the proper working range. We have done considerable work on pulling tensile tests at high temperatures to determine the temperature at which the steel has the greatest ductility. On one grade of high alloy steel, we found there was a range of 200 degrees F in which it cracked. Therefore, when the steel started to crack in rolling, we held it until the temperature dropped 200 degrees and then continued rolling, thereby saving some conditioning and extra conversions.

P. S. Kingsley: I am more or less interested in rolling a low carbon sheet, and was very much interested in Mr. Richey's comments, especially on the carbon distribution. They are rather illuminating. What was the effect on ductility in cold reduced, annealed stock caused by the carbide distribution?

W. H. Richey: We have gone into that extensively and found, especially after tinning, that ductility is materially increased, and also, as mentioned, the bend properties were much better particularly those made transversely.

W. F. McGarrity: I was interested in Mr. Richey's photomicrographs, and particularly in the one with coarse surface grains and extremely fine center grains, finished below 1590 F, as I recall. It should be pointed out that segregation in such rimmed steel also plays an important part in causing this uneven condition.

Box annealing of hot strip is rather seldom employed, due to the hazard of growing extremely large grains when the initial grain size is uneven. A normalizing operation is customarily used when the hot rolled material is of such light gauge that it is not possible to hold to a finishing temperature above 1600 F. This treatment assures even grain size, a softer product, and one adaptable to severe draws. Such a normalize, however, does not completely erase the effect of center segregation.

The effects of center segregation follow through in rimmed steel product which is cold reduced and box-annealed, and cause uneven grain structure from surface to center of the finished sheet material. To offset the effects of segregation, top cuts are often diverted to less important and less severe drawing jobs.

E. L. Robinson: I was particularly interested in Mr. Richey's paper and agree substantially with everything he said particularly in regard to the effect of finishing and coiling temperatures on the finished properties of cold reduced sheets. It appeared to me that Mr. Richey was speaking of open steels primarily in his remarks, and I would like to ask if he has anything to add on the effect of hot mill temperatures on the properties of the low carbon killed steel which is coming into vogue for deep drawing applications.

W. H. Richey: Our experience along that line has been somewhat limited. From investigations made so far, we have found a beneficial effect with lower hot mill finishing temperatures in getting a uniformly elongated grain structure. We believe this is mostly due to steel quality, that is, the way it is handled in the open hearth, and the aluminum content.

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by L. L. Swift, ENGINEER

THE WELLMAN ENGINEERING COMPANY

CLEVELAND, OHIO

▲ UNDER the present conditions of wartime shortages, industrial and domestic fuels are among the most critical items we have to deal with, and engineers concerned with the use, conservation or substitution of fuel should put forth every effort to promote fuel burning efficiency. This is not only a wartime emergency but is necessary to conserve the country's declining natural resources.

The three most widely used fuels are natural gas, oil and coal. It has been necessary for government agencies to restrict the use of the first two to domestic users and to those industries and applications most necessary to the war effort. The use of coal has not been subject to much regulation other than requests to use it in the most efficient manner, and in many cases heating applications have been changed for the use of coal either by government direction or necessity due to shortage of natural gas and oil.

Various geological authorities estimate that the known supply of natural gas and oil will last from 15 to 50 years at the present rate of consumption, while the supply of coal appears sufficient for several hundred years. This would indicate that eventually every large user of fuel will be obliged to use coal in some form.

The most popular method of burning coal is on grates of boilers, locomotives and furnaces. A large amount of coal is used in coke ovens where the volatiles are driven off by the application of heat and the fixed carbon in the form of coke is used mainly in the manufacture of steel. A not inconsiderable proportion of the yearly production of both bituminous and anthracite coal is used in gas producers.

Until the early 1920's, producer gas was by far the most widely used gaseous fuel in the steel, glass, ceramic and lime industries. About this time the heavier by-product oils from the refineries became plentiful and cheap — in fact, almost an unsaleable product. Natural gas pipe lines from the South and West brought, at the same time, an almost unlimited supply of fuel to the large industrial centers of the country. Other fuels that were making their appearance in considerable proportions were gas from the increasingly popular by-product ovens and blast furnace gas.

These fuels were cheap, easily applied and controlled, and their use actively promoted by representatives of the gas companies and oil refineries. Coke oven and blast furnace gas were often produced in excess of the prevailing demand, and fuel engineers naturally developed new uses for them within their plants. An advantage of these fuels was their availability, as well as the ease and accuracy of automatic temperature and

Presented before The Cleveland Engineering Society, March 27, 1944.

combustion control. For the above reasons the use of producer gas gradually declined until steel and glass plants using producers were almost considered old fashioned.

The early gas producers were dirty, smoky and subject to breakdowns at critical times, they requiring frequent shut-downs for cleaning flues, valves, and burners. Many purchasers of producers considered them a necessity but in the interest of economy spent as little money as possible on the installations. Too often, their own designs of building, flue system and burners were installed without consulting a producer builder or competent engineer, and as a result many gas plants were poorly arranged, difficult to operate, dirty, smoky, unreliable and unsatisfactory to both the owner and producer manufacturer. To a considerable extent this condition still exists, although some of the most modern and efficient producer gas plants were owner designed.

Previous to 1920, gas producer sales ran into many hundreds per year. After that date the sales noticeably dropped. New industries seldom bought producers, and at the height of the late depression, sales dropped to near the vanishing point. Then about 1939 increased interest in gas producers was discerned for the following reasons:

(a) Natural gas wells in southern New York state and northern Pennsylvania were rapidly dropping in rock pressure; in many cases the wells had ceased producing.

(b) Industrial natural gas rates in many areas were sharply increased, in some cases as much as 60 per cent.

(c) Developments in refinery practice greatly reduced the amount of heavier fuel oils, naturally increasing the price of the reduced quantity.

(d) The oil requirements for war restricted the supply for all but the most essential industries.

(e) The use of natural gas in war industries had so taxed pipeline capacity that there was not enough available gas during the winter season when the heaviest domestic load was reached. Commercial demand was made second to domestic requirements.

In the past five years the writer's company alone has installed approximately 120 producers which with their accessories such as building, coal and ash handling equipment, gas pumps, etc., represent a value of around $5,000,000 and which use about one and one-half million tons of coal per year. At the present time the market for gas producers appears brighter than for many years and as the possible users become better acquainted with the modern gas producer, the prospects should continue to improve.

The modern producer plant is supplying gas for practically every industrial purpose and in most cases at a cost less than other available fuels. We have yet to find a case where the quality of the product is not equal to that made with any other fuel.

Producers are supplying gas to soaking pits, heating furnaces, annealing and heat treating furnaces, open hearths, glass tanks, pottery and brick kilns, rotary and vertical lime kilns, underfiring coke ovens, ore roasters, and even to bakeries and canneries.

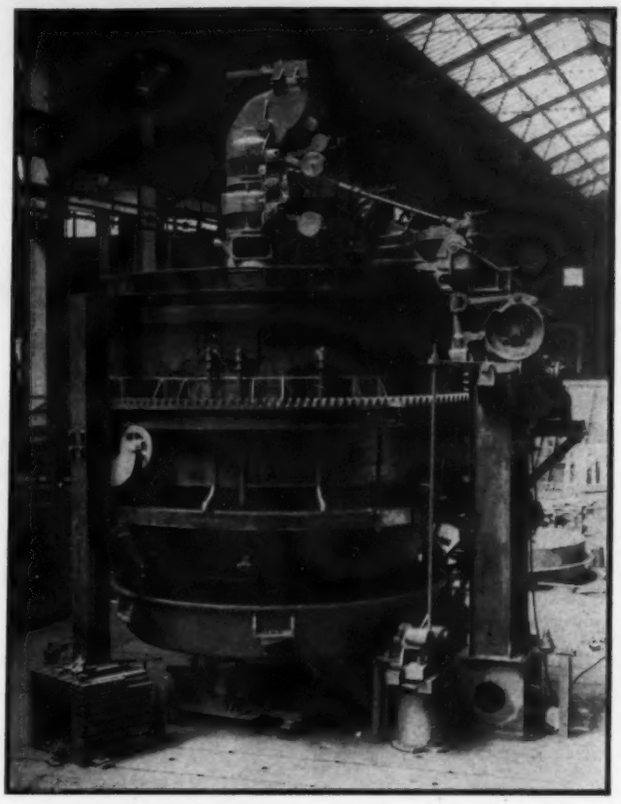

Figure 1 — Shop view of an 11 ft water-jacketed bituminous producer.

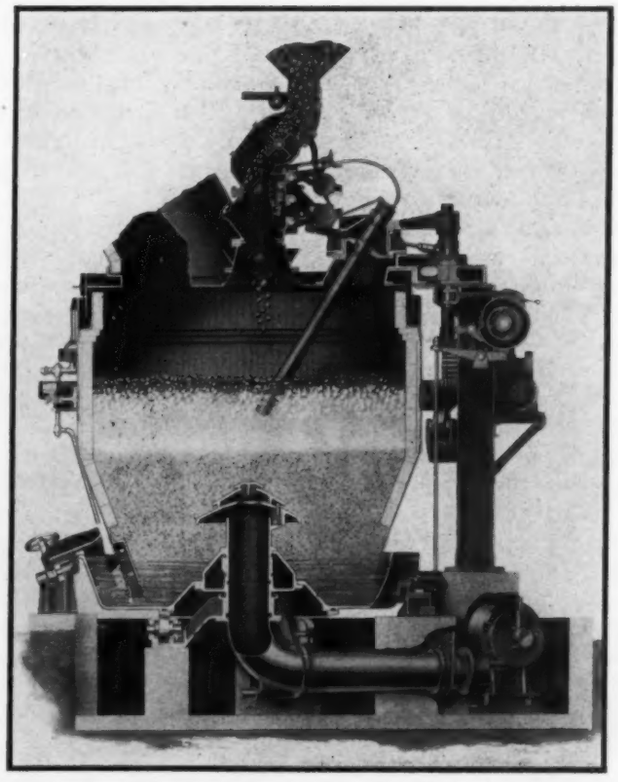

Figure 2 — Cross-sectional view of brick-lined bituminous producer.

Two customers operating gun forging plants use producer gas for all heating operations with the exception of electric melting furnaces, the gas being used for soaking pits, ingot forge furnaces, ordinary annealing, isothermal annealing, normalizing, hardening and drawing furnaces. One of the gun plants operates its producers on rice size anthracite coal and have available clean hot gas at 8 in. static pressure and cold washed gas at 3 psi pressure. The other plant operates its producers on coke breeze and uses hot gas at ½ psi pressure, the gas in both plants being piped upwards of 2000 ft. Other customers use clean hot gas made from anthracite coal in ore roasters for refining zinc and nickel. Cold washed anthracite producer gas has been particularly successful in heating operations requiring accurate control of temperature and furnace atmosphere.

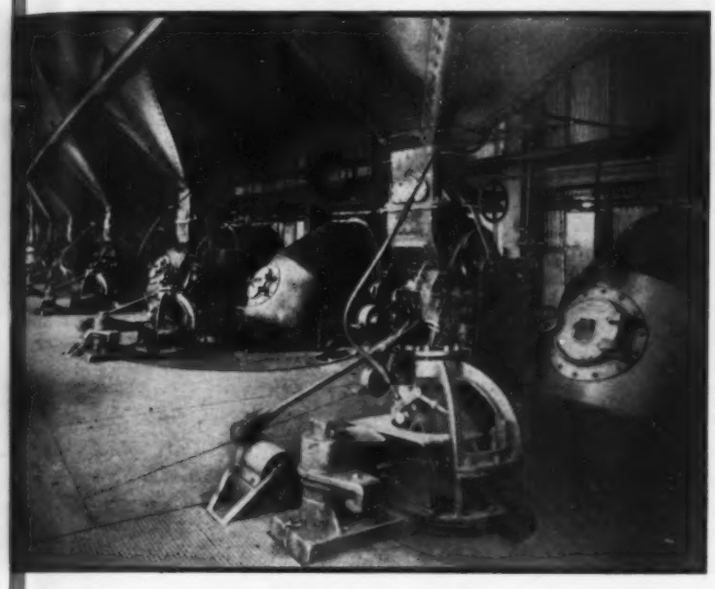

Figure 3 — Operating floor of nine bituminous producers.

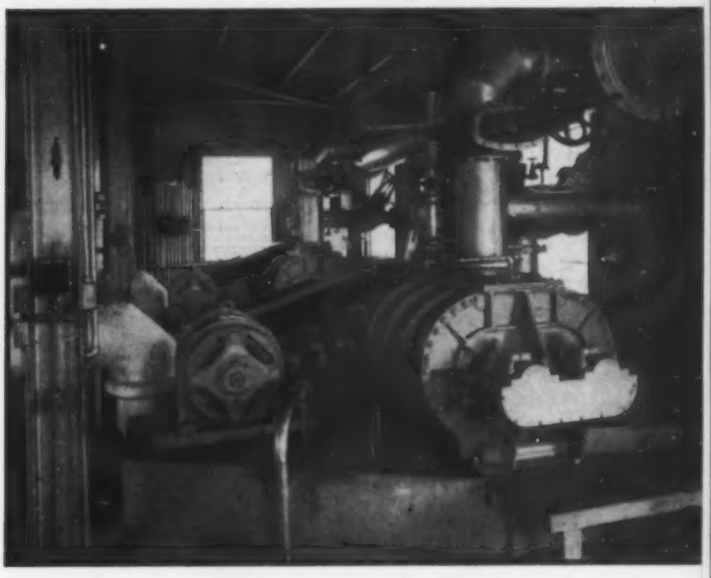

Figure 4 — Gas pumps and piping in a washed gas anthracite producer plant.

Producer gas made from bituminous coal is mostly used in the hot state for applications requiring large amounts of fuel in open hearths, soaking pits, glass tanks, lime kilns, and other furnaces. This gas has been used successfully on annealing and normalizing furnaces where proper consideration was given to the design of the furnace and burners.

At the present time most combustion or fuel engineers consider it practically impossible to successfully wash and clean producer gas made from bituminous coal due to the large amounts of soot, fly ash and tar vapor suspended in the gas. However, soot and fly ash can be easily and completely removed in water spray towers, while wood slat scrubbers will remove tar vapor sufficiently to permit use of the gas in burners not having too small orifices. A large southern chemical plant has for the past twelve years used washed bituminous producer gas in their furnaces after the tar (collected in spray towers and scrubbers) has been removed.

Thirty years ago producer plants were built in which the gas was cleaned for use in internal combustion engines. Producer gas for this service must be equal to natural gas in cleanliness, as even a trace of tar vapor would soon cause sticking valves and frozen piston rings, and would eventually stop the engine. It should be noted, however, that in these early gas plants the cleaning equipment was very expensive, both in first cost and upkeep, and in addition required experienced operators.

Producer gas is generally called a lean fuel because of its low calorific value of 150 to 160 Btu per cubic foot. Typical examples of producer gas composition are as given in Table I. The blow Btu content of producer gas does not appear so unfavorable when the combustible air-gas mixture is considered. On this basis producer gas is approximately 30 per cent richer than blast furnace gas and from 15 to 20 per cent leaner than natural or by-product gas.

TABLE I

Analyses of Producer Gas

Fuel used	CO	H_2	CH_4	CO_2	N_2	0_2	Btu per cu ft
Bituminous Coal	25.0	14.49	3.14	4.69	52.68	0.0	167
Anthracite coal	27.1	16.6	0.9	5.0	50.4	0.0	151
Coke breeze	30.96	9.30	0.70	3.56	55.43	0.05	137

Hot producer gas made from bituminous coal will equal other high Btu fuels for nearly all heating operations, the highly luminous flame compensating for the lower Btu value. Hot coke or anthracite producer gas does not burn with a luminous flame and will require more Btu for a given heating problem than natural gas, especially at high temperatures. At temperatures under 2200 F there is not a very great difference. When using washed producer gas, 15 to 20 per cent more Btu will be required than with natural gas or oil. However, the increased volume of combustion products makes recuperation or regeneration more effective and this partly offsets the higher Btu requirements. The effect of the large volume of combustion products is particularly noticeable in furnaces having long preheat zones such as continuous tunnel kilns. In one instance, oil was replaced by washed producer gas and the kiln capacity was increased approximately 25 per cent without increasing the Btu requirements.

One plant, now operating 10 producers, changed from oil to producer gas on their soaking pits and forge furnaces, and stated the furnaces were heating as fast as when oil was used. The fuel consumption was the same, but the quality of heating was so much improved that they would not go back to oil if it could be gotten without cost, the cost of their coal being $7.00 per ton. Another plant operating 7 producers replaced natural gas with washed anthracite gas on forge furnaces and save 10¢ per million Btu on their fuel bill in addition to making an appreciable reduction in scale loss.

The fuels used to make producer gas are, in the order of the amount used, bituminous coal, anthracite coal, and coke breeze. An ideal bituminous coal is 1¼ in. screened washed nut, low in sulphur, not over 10 per cent ash, ash fusing temperature of 2500 F or over, and having about 14,000 Btu per pound. Such a fuel is now hard to obtain and would be expensive, if obtainable. As an alternate, producer operators use slack or crushed run-of-mine, of low fusing ash and high sulphur — in fact, almost anything that will burn. The results, of course, are far from perfect, but with intelligent operation a fair quality of gas is being made.

The anthracite producer is designed to operate on rice size anthracite coal which should not contain over 15 per cent dust, 10 per cent ash and 5 per cent volatile, and should have an ash fusion temperature of 2700 F or over and contain 13,500 Btu per pound. Such a coal will usually have a sulphur content so low that it will not affect the material being heated. This producer is also used to gasify coke breeze, the only requirements being that at least 17 hour coke be used, containing no fines under ⅜ in. or lumps over 1¼ in.

The 10 ft bituminous producer will gasify 6000 pounds of average coal per hour and deliver about 70,000,000 Btu. The 10 ft anthracite machine will gasify 2000 lb per hour and deliver 23,000,000 Btu. With coke breeze, size ½ in. and over, the capacity is 3000 pounds per hour, delivering something over 30,000,000 Btu. The above are capacities an average operator should maintain without too much difficulty. We have operated these producers at 33 per cent to 50 per cent higher rates with calculated efficiencies of 85 per cent, while in actual practice 90-93 per cent efficiencies have been obtained.

The cost of producer gas consists of the following

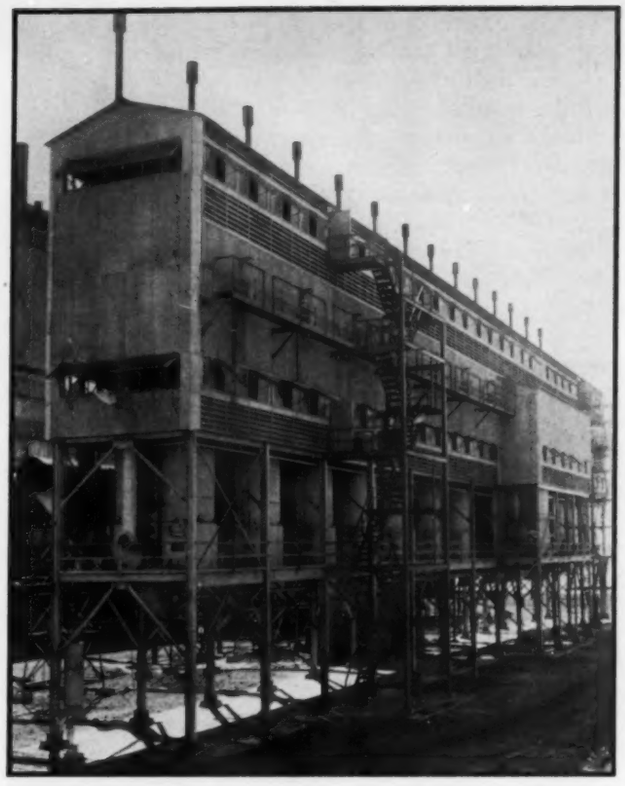

Figure 5 — Fourteen anthracite producers in operation in Cuba.

items: coal or coke, operating labor, water, steam, electric power, maintenance, interest and amortization of the capital expenditure.These costs will vary with the location of the gas plant and the method of cost accounting. Coal may cost anywhere from about $2.00 up per ton delivered. The total of other operating costs will vary from about 75¢ to $2.00 per ton of coal used. This results in a gas cost of 12¢ per million Btu minimum to 55¢. The latter is the highest cost reported by any of our customers.

At present three companies build about 95 per cent of all producers sold in the United States; these are the Morgan Construction Company of Worcester, Mass., R. D. Wood Company of Philadelphia, Pa., and the Wellman Engineering Company of Cleveland, Ohio.

We do not know what other companies are doing in the development of new and improved producer equipment, but due to the increasing scarcity and higher prices of desirable fuels, we are now testing a new machine for gasifying barley size anthracite. We are also testing a wood burning producer for supplying gas to an industrial type gas engine. Results of these tests are not yet ready for publication, but we are quite optimistic.

In addition to the foregoing, our engineering department is now designing a small wood burning producer that would be suitable for small gas engines, motor trucks, busses, motor boats, etc., and a larger sized producer that will deliver a hot tar-free gas from low grades of bituminous coal. Indications are that the postwar period will see a rejuvenation of producer gas to the popularity that it enjoyed in the nineteen twenties.

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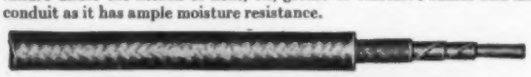

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J. F. BLACK
BUFFALO DISTRICT

NEW DISTRICT CHAIRMEN, A. I. S. E.

W. T. Adams, after graduation from Hiram College, joined the Ohio Power Company in 1919 in test and construction work. In 1920 he moved to the Berger Manufacturing Company at Canton, Ohio, where he worked in various departments until that company became a part of United Alloy Steel Corporation. After four years in the claim department of the latter company, Mr. Adams joined the Moock Electric Company as sales manager. In 1933 he joined the purchasing department of Republic Steel Corporation and is now in charge of all electrical purchases, with headquarters in Cleveland, Ohio.

John F. Black received his elementary schooling in the Enid, Oklahoma, city schools, and attended the United States Naval Academy, class of 1926. He started in the steel business as pipefitter helper at Bethlehem Steel Company's Sparrows Point plant, progressing to steel shipper, labor foreman, gashouse foreman, general foreman of gas producers, combustion engineer, and general foreman of pipe mills. In 1941 he transferred to Atlas Steels Limited, Welland, Ontario, as fuel engineer and in 1943 was made assistant works manager.

Harold E. Phelps has worked with electric furnaces since 1917. His early experience was with the Steel and Tube Division of Timken Roller Bearing Company, Canton, Ohio. He then transferred to Rotary Electric Steel Company at Detroit, Michigan, and has served as superintendent of electric furnaces there since 1933. He is a past president of the Electric Metal Makers Guild.

R. E. Bobbitt was graduated in electrical engineering from Georgia School of Technology in 1918. He then entered the engineering department of Magnolia Petroleum Company, Beaumont, Texas, and soon moved to the engineering department of Atlantic Steel Company, Atlanta, Georgia. In 1920 he joined the Armour Fertilizer Works in Atlanta, returning to Atlantic Steel in 1922. Transferred to the mechanical department in 1923, he was made general master mechanic in 1939, in charge of mechanical, electrical and steam engineering departments.

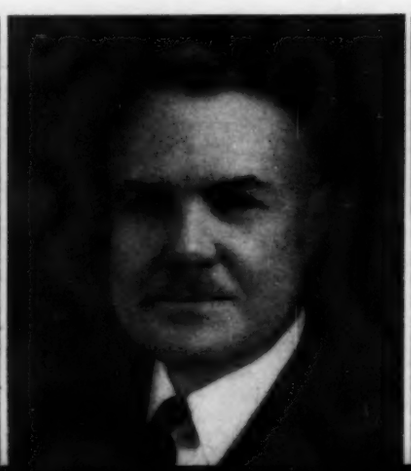
Louis Moses started work with the Cambria Steel Company at Johnstown, Pennsylvania, as office boy and successively progressed as apprentice, machinist and mechanical draftsman on mill and machinery construction, maintenance, etc. He then entered the field of roll designing, where his experience embraced large and small rolling mills, extending later to the development of the varied rolling and manufacturing facilities of the expanding Sparrows Point plant of Bethlehem Steel Company, and to the supervision of operations of the rail mill at that plant.

T. R. Moxley started as an apprentice in the shops of the Tennessee Coal, Iron and Railroad Company in 1903 and worked in the mechanical and engineering departments until 1921, when he became master mechanic of Woodward Iron Company's coke plant. In 1924 he returned to the Tennessee Company as assistant master mechanic of sheet mills, and in 1927 moved to Wheeling Steel Corporation as coke plant master mechanic. He was subsequently made assistant general master mechanic and in 1934 was appointed general master mechanic.

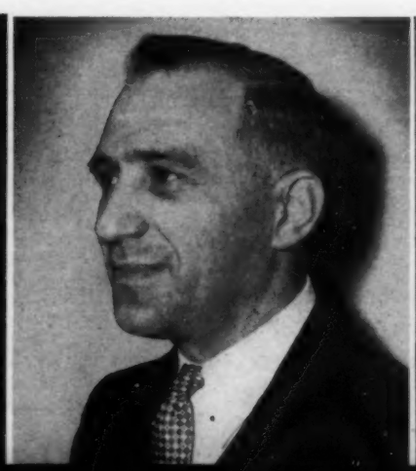
Victor E. Schlossberg started with the Inland Steel Company in 1926 upon graduation from Rose Polytechnic Institute. He assumed his present duties as assistant superintendent of electric and power departments in December, 1930.

W. T. ADAMS
CLEVELAND DISTRICT

HAROLD E. PHELPS
DETROIT DISTRICT



VICTOR E. SCHLOSSBERG
CHICAGO DISTRICT



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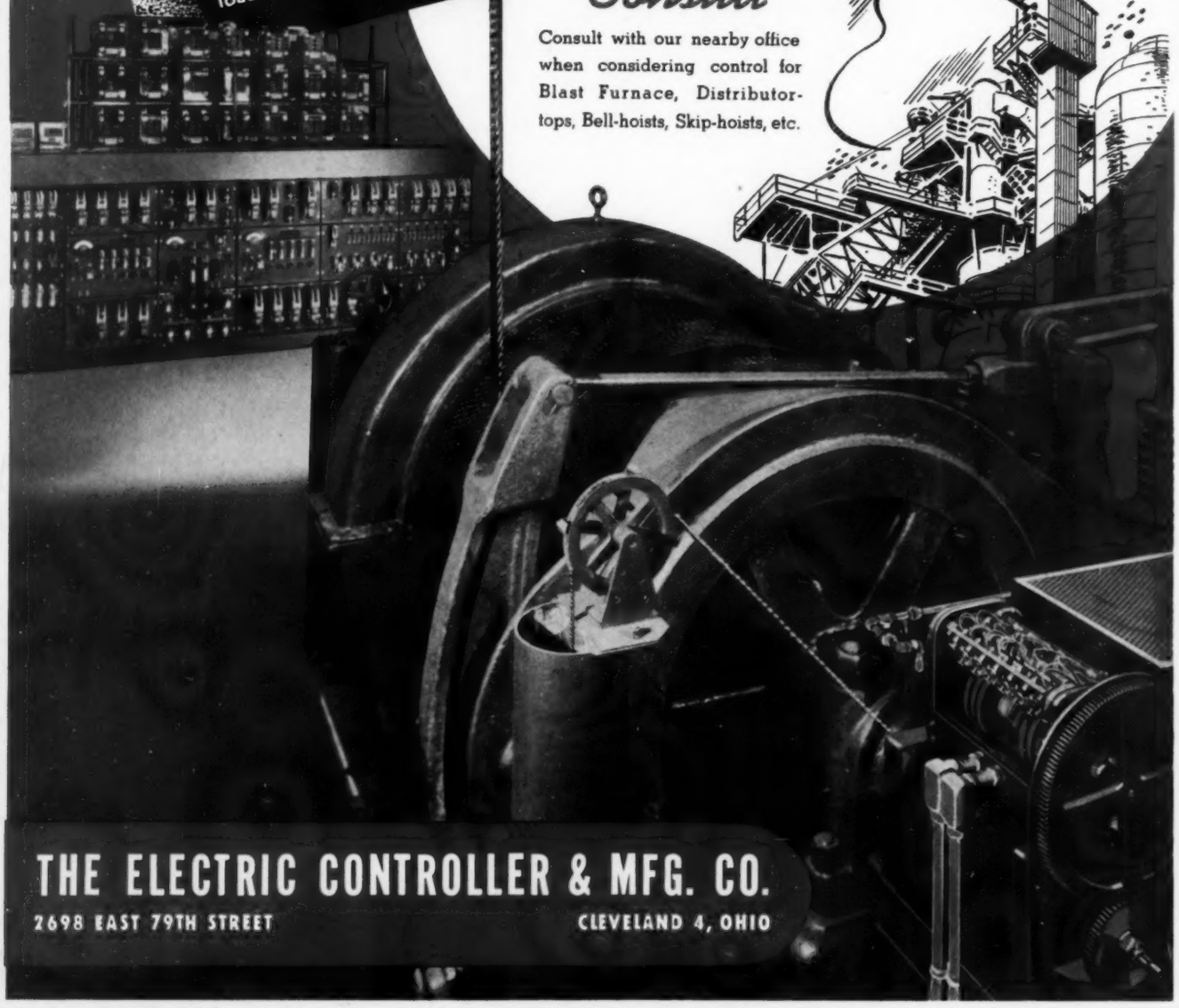

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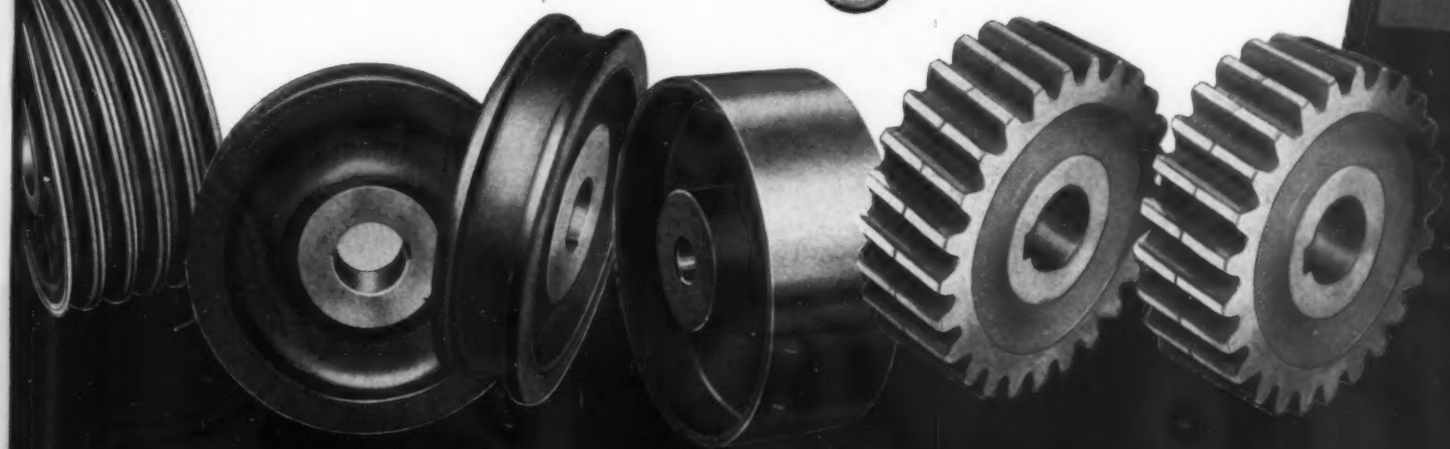

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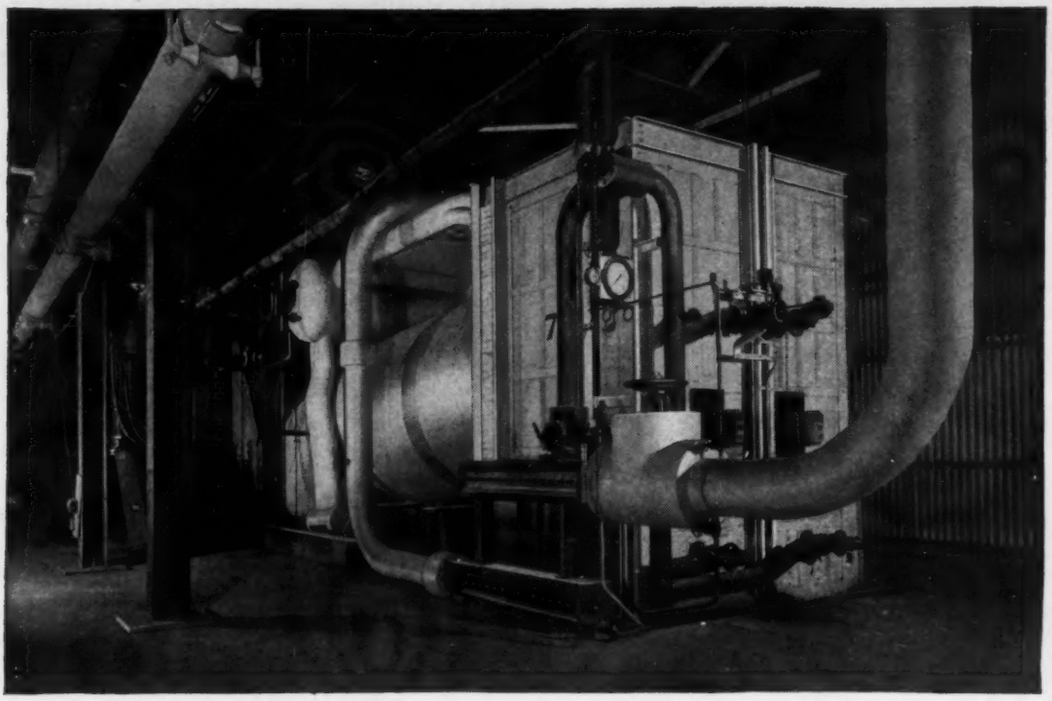

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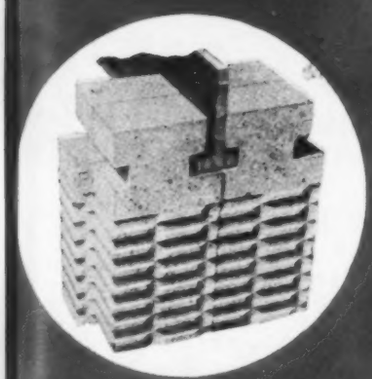

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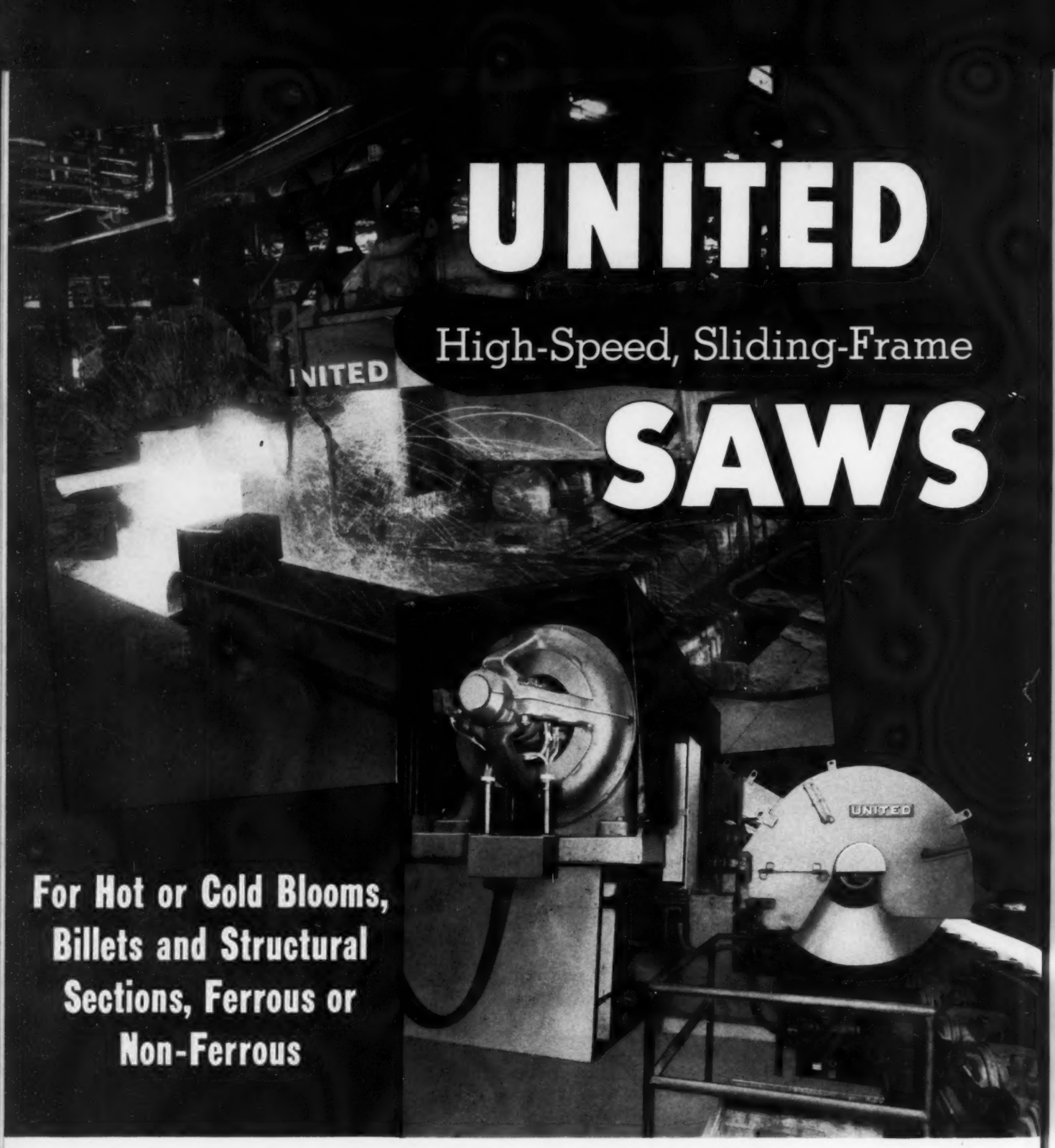

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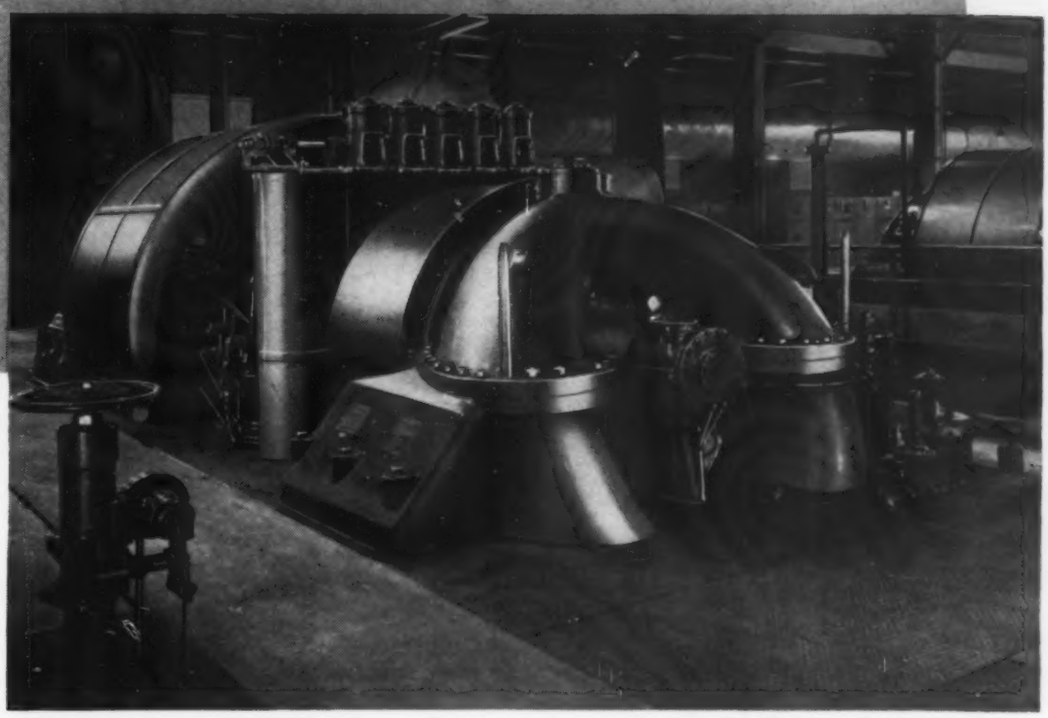

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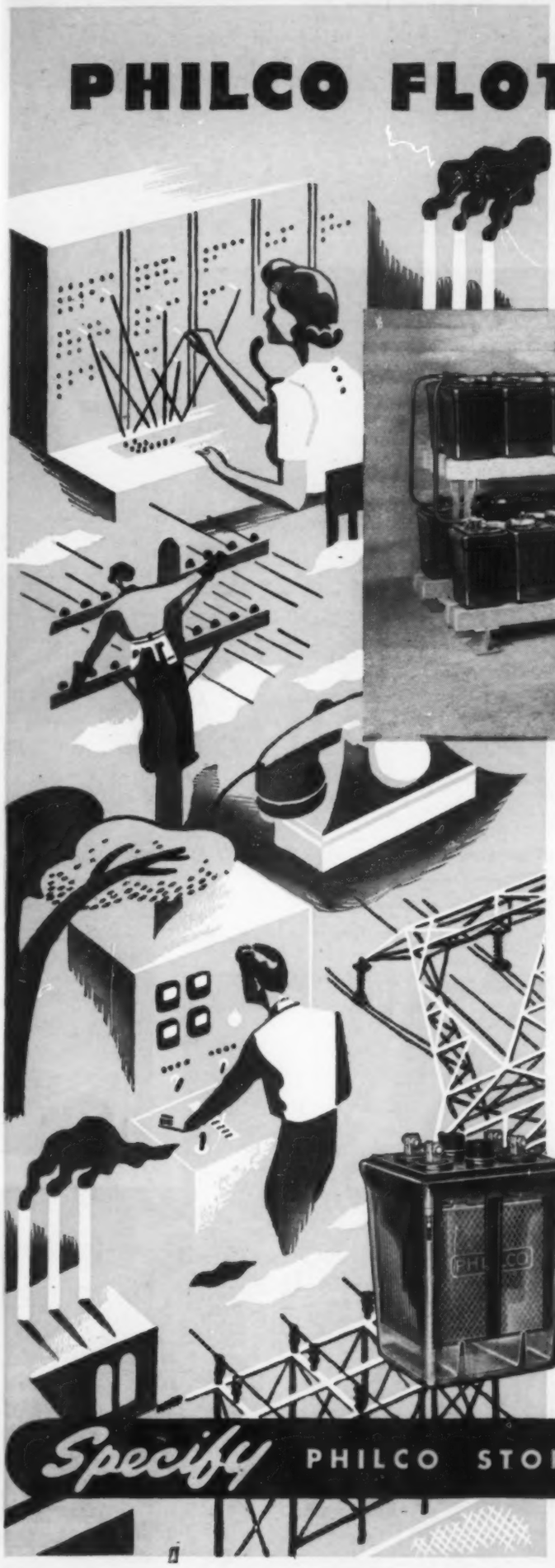
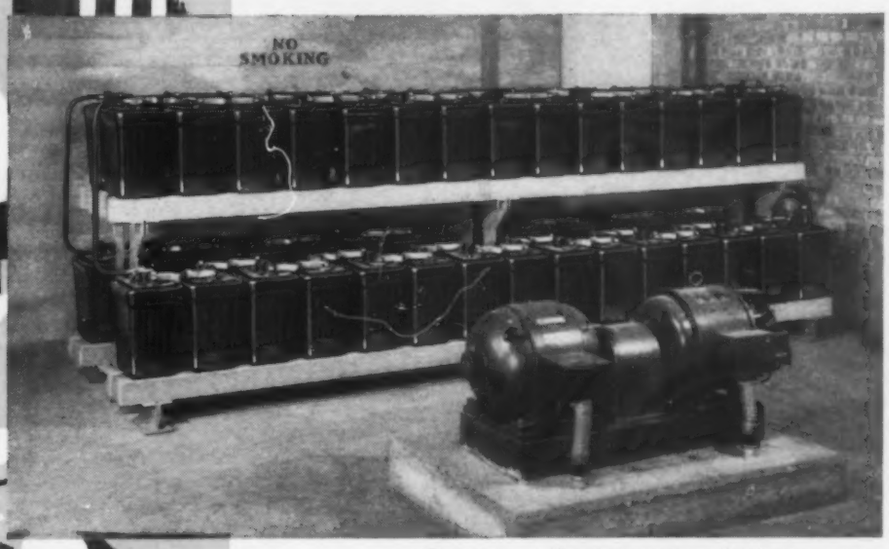
When *you* select arc furnace control equipment, be sure to make Westinghouse *your* first choice. This holds true for the furnace transformer, the switchgear and the electrode control itself. Westinghouse is the *only* manufacturer that makes *all three* types of control—Balanced Beam, Rototrol Variable Voltage or Electronic Regulator types. For complete information call your nearest Westinghouse office. Westinghouse Electric & Manufacturing Co., Box 868, Pittsburgh 30, Pa. J-94652

PHILCO FLOTE BATTERIES

ELIMINATE THE PROBLEM OF LOW CELLS IN FULL FLOAT SERVICE





One of several 60 cell oil switch control batteries operating in a new and modern electric steel plant in the Chicago District.

When Philco engineers pioneered the famous Floté grid, they eliminated for keeps the problem of low cells in full float service. By casting the grid in a special metal, developed by Philco research expressly for this purpose, they changed the chemical reaction within the cell so as to remove the *cause* of low cells. This important milestone in storage battery progress is one of many advanced features which make Philco Batteries tops in efficient, trouble-free performance and long service life. It is one of the reasons why so many prominent users of control and auxiliary power storage batteries specify Philco, over and over again. The Philco Battery illustrated is available in cell capacities from 10 A.H. to 1056 A.H. Write for catalog.

PHILCO CORPORATION

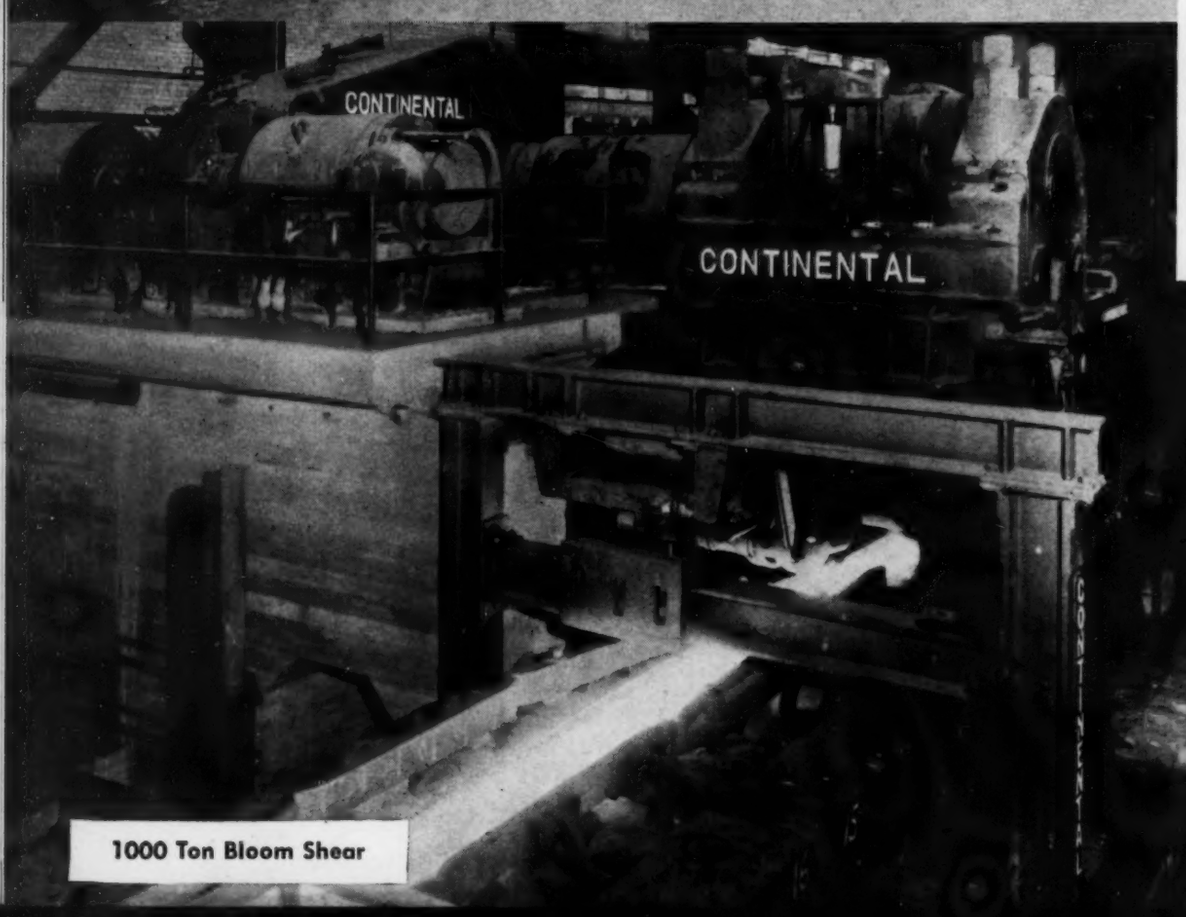
Storage Battery Division, Trenton 7, New Jersey

Specify PHILCO STORAGE BATTERIES

ARMY E NAVY

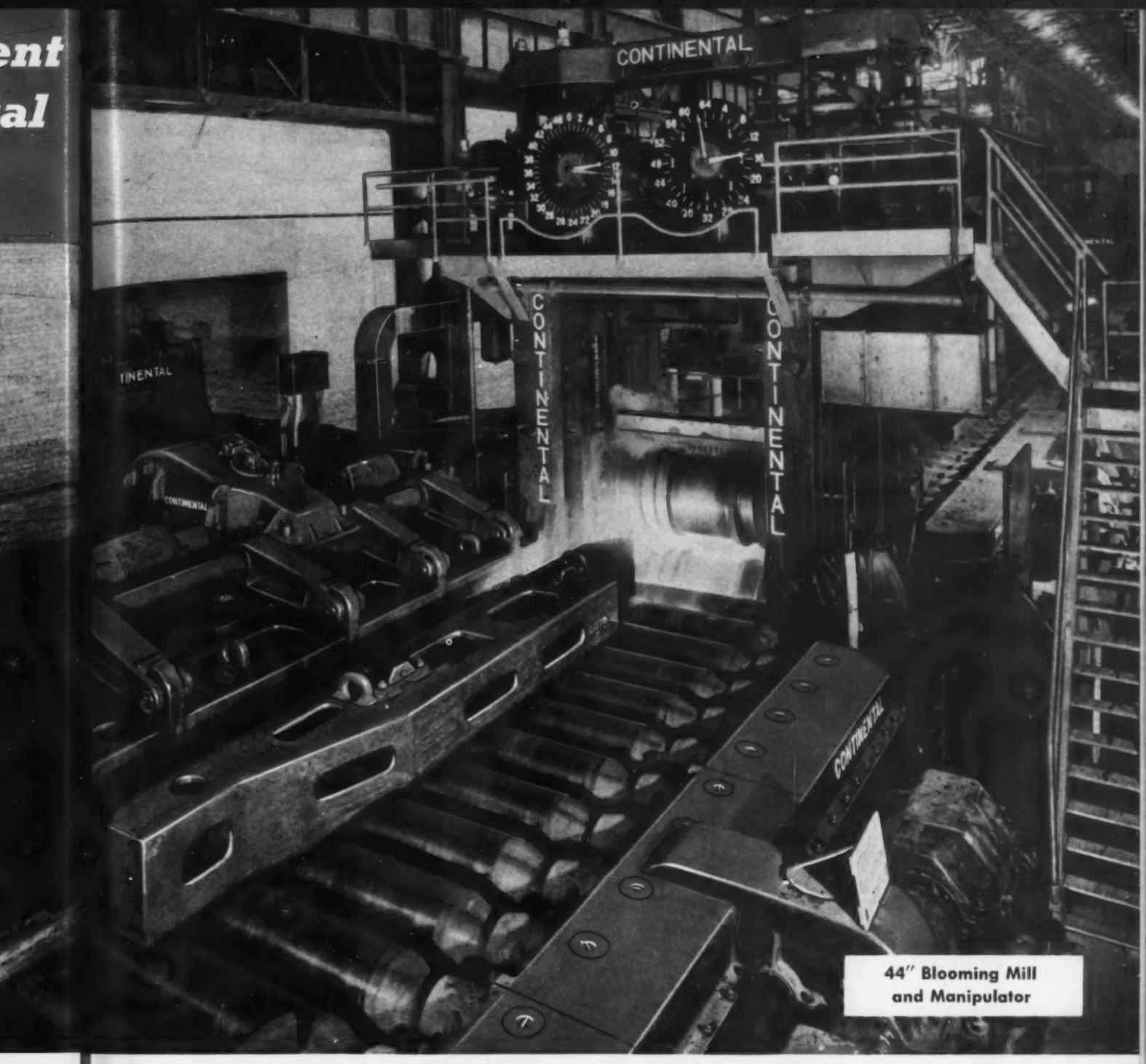
New Blooming Mill and Equipment Designed and Built by Continental To Speed Steel Production

Shear Depressing and Pull Back Table and Shear Gauge for 1000-Ton Bloom Shear



1000 Ton Bloom Shear

Continental manufactures Carbon and Alloy Steel Castings, Roll Rolling Mill Equipment and Special Machinery



44" Blooming Mill
and Manipulator

CONTINENTAL FOUNDRY & MACHINE COMPANY

CHICAGO • PITTSBURGH

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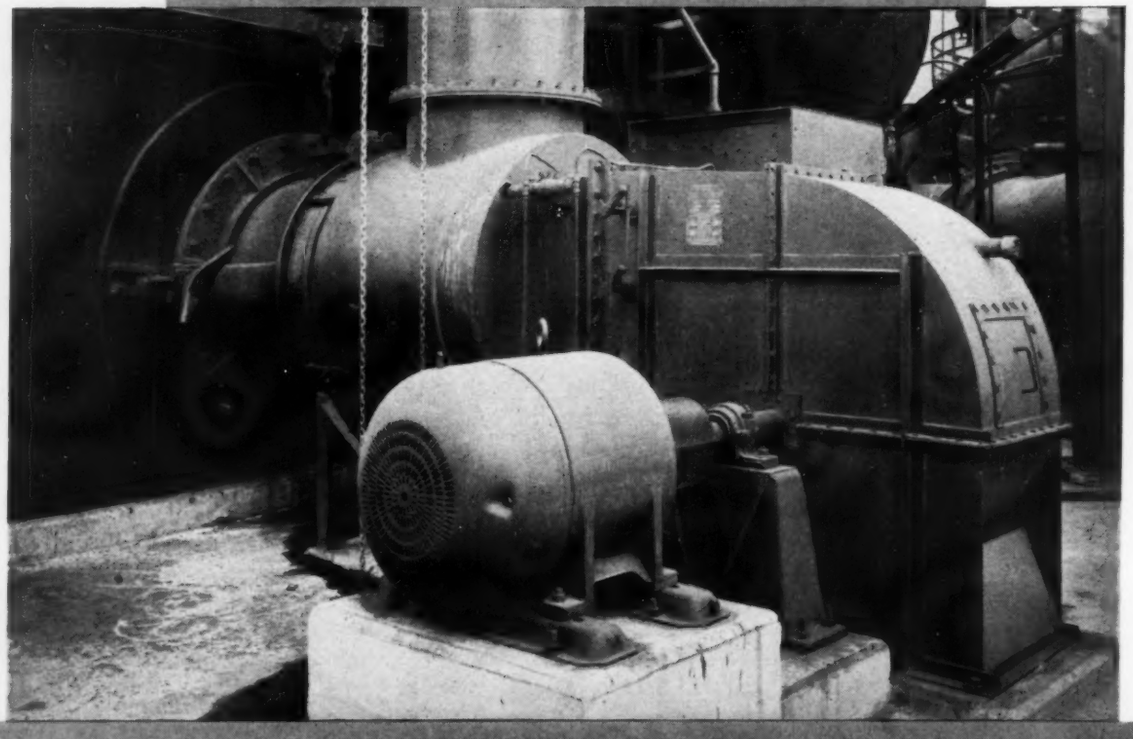
FREYN DESIGN

Blast Furnace Stove

PRESSURE BURNERS

EMBODY THE EXPERIENCE GAINED IN DESIGNING, CONSTRUCTING AND SERVICING 154 PRESSURE BURNERS DURING THE LAST FIVE YEARS



Installed in a new plant in the Chicago district

Freyn Engineering Company

CONSTRUCTORS — ENGINEERS — SPECIALTIES

310 SOUTH MICHIGAN AVENUE · CHICAGO 4, U.S.A.

ASSOCIATED WITH:
ASHMORE, BENSON, PEASE & CO. LTD., STOCKTON-ON-TEES, ENGLAND

THIS CAPACITY is part of America's heritage. A splendid example of it is the new electric steel plant in the Chicago district.

Not only was it built quickly to supply high-grade steels for important war materials, but it is the last word in modern, efficient electric steel plants.

America's heritage permitted such war plants to spring up almost overnight everywhere . . . a heritage of wisdom based on research, inventiveness, experience, and brave commercial and industrial undertakings.

That this is the largest electric furnace plant ever built is a tribute to the vision of its planners. We are proud and happy to be the suppliers of the 20-inch graphite electrodes that serve all of the plant's nine electric furnaces.

KEEP YOUR EYE ON THE INFANTRY . . .

THE DOUGHBOY DOES IT!

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Unit of Union Carbide and Carbon Corporation
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GENERAL OFFICES: 30 East 42nd Street, New York 17, N.Y.
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NATIONAL CARBON — ACHESON GRAPHITE

The "National" and "Acheson" Seals distinguish products of National Carbon Company, Inc.

at the new electric steel plant in the Chicago district

LINK-BELT

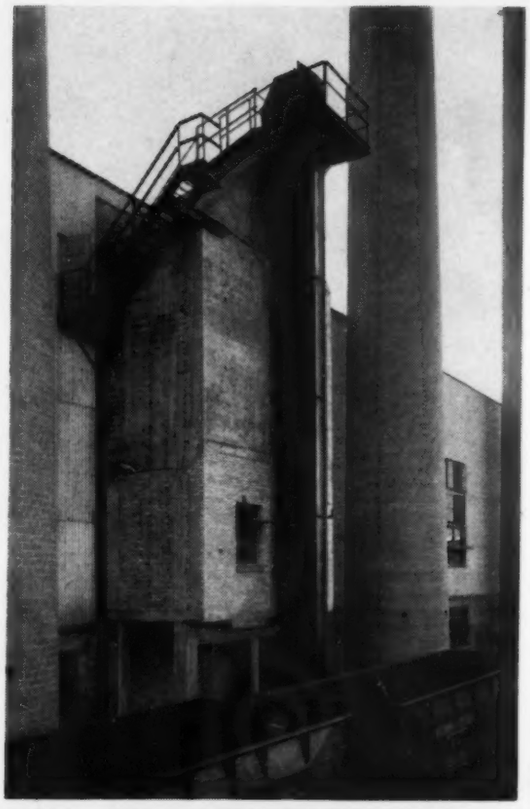
CONVEYORS

help speed the flow of production

Right: Coke breeze handling equipment which consists of Link-Belt track hopper, belt conveyor-feeder, bucket elevator to top of silo and duplex gate.

•

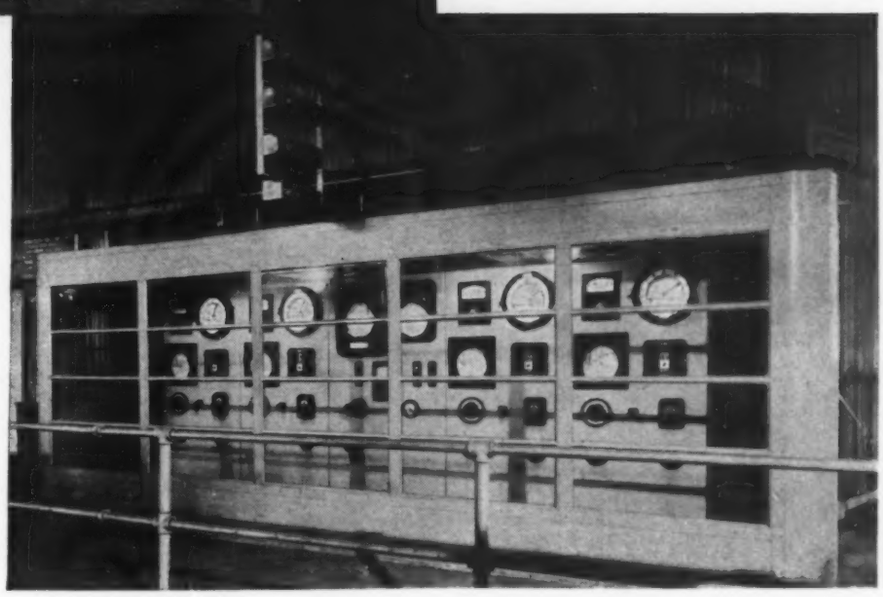
Left: Link-Belt feeder-belt conveyor Part of coke breeze handling equipment shown at right.



Link-Belt 12" pitch chain for heavy billet transfer between shear run out table and furnace table. Also used on cooling conveyor. Furnished through Continental Foundry and Machine Company.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Toronto 8. Offices in principal cities. 9717



Above — Six batteries of Surface Combustion soaking pits; four pits per battery; a recent installation in a midwest steel mill. Behind each battery is its control cubicle from which temperature, pressure and combustion are automatically regulated with extreme precision.

Right — Control cubicle for four Surface Combustion soaking pits. Panel at center supplies gas fuel, and constant-pressure combustion air, to all four pits. Each individual panel has Micromax Electric Control equipment for temperature, Hays Recorder for fuel and air flow and Indicator for furnace pressure, and Askania fuel-feed setters. As explained below, control action is pinned to the Micromax Pyrometer.

depends on me!
A Slogan For Every American

THEY "*Instrument-eered*" THESE PITS FOR FAST, ACCURATE HEATING

The designing and operating engineers who are responsible for the soaking pits shown above have worked out an unusually efficient way of controlling these big furnaces. The entire installation demonstrates the extent to which automatic control is relied on, in modern installations, to maintain the temperature and combustion desired.

Automatic control is based on temperature, which is regulated by Micromax Pyrometers — one for each pit. The principle is that the Micromax regulates combustion air, and the fuel (gas) is then adjusted to match.

The Micromax uses a Rayotube (radiated-heat) detector, installed in the back wall of the pit and set high above the floor so that the ingots cannot shield it from heat. The refractory around the Rayotube is recessed but the tube itself projects flush with the inside wall. It has a water-cooled head, and a safety shutter protects against unexpected or abnormal failure of the tube. Installed in this way, Rayotubes last for years.

The Micromax, constantly measuring the temperature at the Rayotube, causes its electric drive-unit to throttle the furnace's air-valve up or down whenever there is a change in temperature. An Askania Regulator measures the air supplied, and feeds the correct amount of gas fuel. Air pressure is constant; ratio of fuel to air can be changed at will; combustion is always efficient and temperature is held with the straight-line steadiness necessary to heat ingots to uniform consistency for quick, accurate rolling into billets, rod plates, shapes, strip or wire.

Micromax Control can be applied to any modern furnace, and will hold it to the narrowest possible temperature band. If you have a specific temperature control problem, an L&N engineer will gladly work with you on it, or send the appropriate catalog, as you prefer.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

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MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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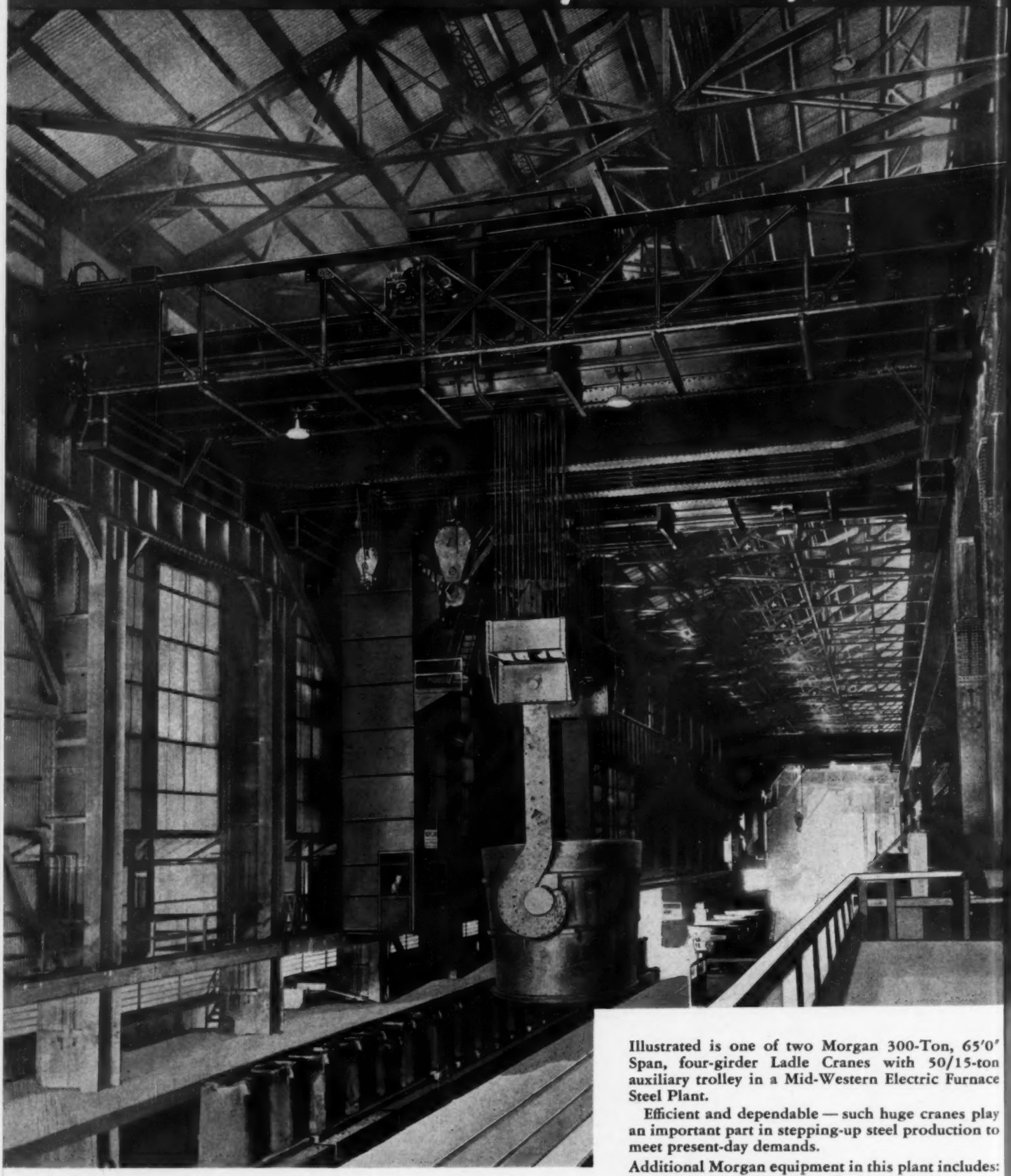
BUILT BY MORGAN *Engineering*



MORGAN 300-TON, 65′0″ SPAN POURING CRANE

Illustrated is one of two Morgan 300-Ton, 65′0″ Span, four-girder Ladle Cranes with 50/15-ton auxiliary trolley in a Mid-Western Electric Furnace Steel Plant.

Efficient and dependable — such huge cranes play an important part in stepping-up steel production to meet present-day demands.

Additional Morgan equipment in this plant includes:
Three 150-Ton, 65′0″ Span Pouring Cranes.
Two 150-Ton, 80′3″ Span Hot Metal Charging Cranes.
Two 200-Ton, 63′0″ Span Universal Type Ingot Strippers.

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

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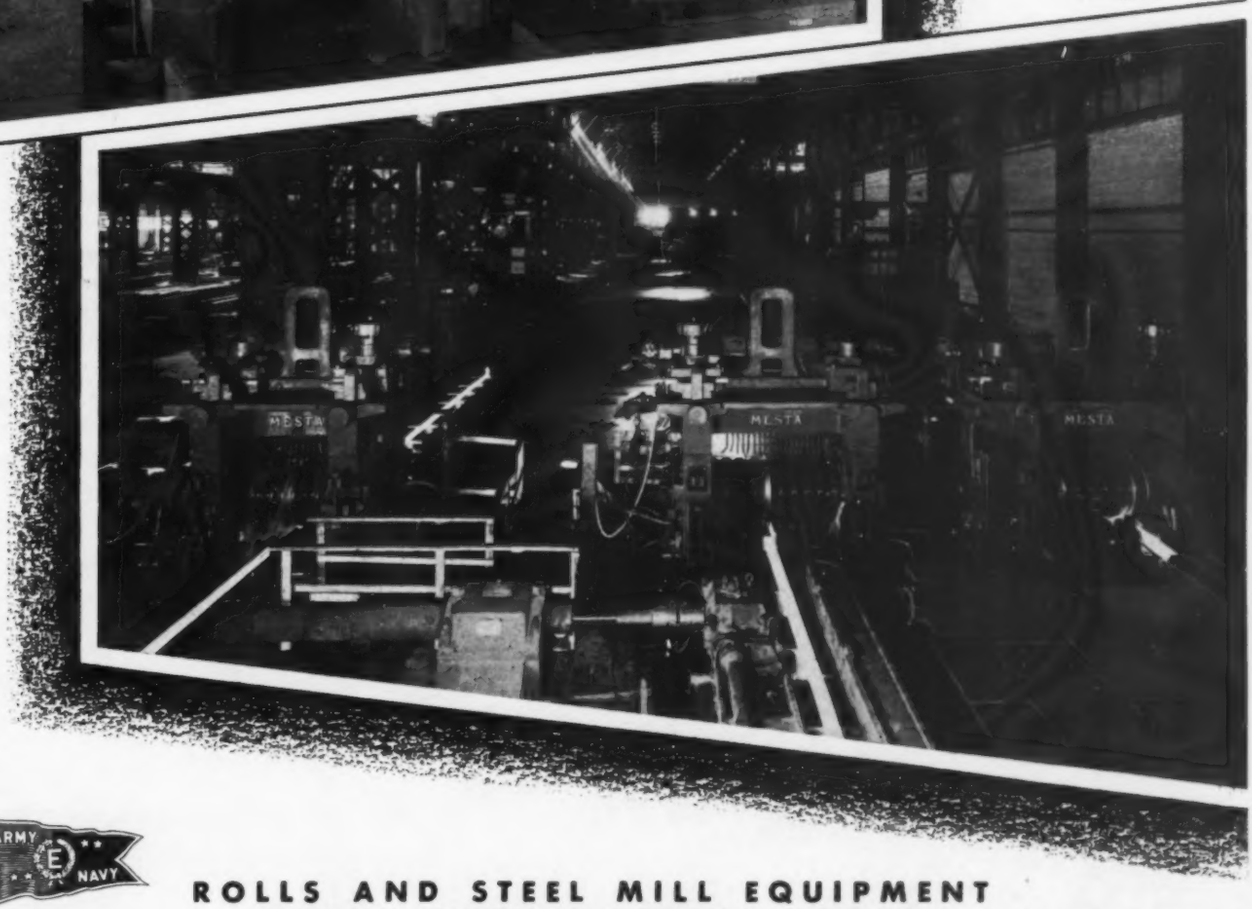
MESTA BAR MILLS

At the Chicago District's new electric steel plant . . . a Mesta 36" Roughing Mill for supplying billets to the 32" Bar Mill. The Leader, Intermediate and Finishing Stand of this mill are shown below.



The Army-Navy "E" flag with four stars, flies over the Mesta Plant

ROLLS AND STEEL MILL EQUIPMENT
HEAVY DUTY MACHINE TOOLS
FORGINGS

BUY EXTRA WAR BONDS

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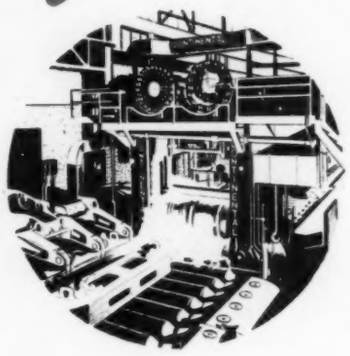


. . . . geared to produce top quality steel from a wide range of materials, this new plant in Chicago is a fine example of modern steel plant design . . . .

by T. J. Ess

▲ ONE of the most important units in the 10,000,000 ton per year expansion program instituted by agencies of the United States Government in the steel industry is the completely integrated open hearth and electric furnace steel plant built at South Chicago, Illinois, for Defense Plant Corporation under the direction of Republic Steel Corporation. Intended primarily for the production of steel for aircraft and gun bloom applications, the plant represents an unusual combination of steelmaking facilities designed to turn out a product of the requisite high quality from the raw materials currently available, all laid out so as to give a direct flow throughout the entire process from coke plant and blast furnace to bar finishing and shipping. This plant, with its large capacity of steels so essential to armament production, represents security from future possible shortages of vital alloy steels, and provides a source of this material in proximity to the heavy consumption now existing in the Chicago area.

The plant site consists of 160 acres, all within the city limits of Chicago, adjacent to Republic's South Chicago works and extending along the east bank of the Calumet River. The property had been previously acquired by Republic for possible expansion of its existing plant. Preparation of the site required the moving of the freight tracks of the Pennsylvania Railroad about 300 ft in an easterly direction, and the moving of a turning basin in the river to a new location south of the existing plant. This work was started January 12, 1942, just 37 days after Pearl Harbor. The first electric furnace heat was tapped April 3, 1943, and the first ingot was rolled on the blooming mill October 20, 1943, a remarkable record in view of the lack of top priorities for the necessary equipment.

Briefly, the plant is composed of by-product coke ovens, a blast furnace, four tilting open hearth furnaces, nine electric arc furnaces, a blooming mill, a bar mill and the necessary auxiliary and finishing equipment. Iron ore, coal, limestone and some scrap form the principal incoming materials. When operating at its nominal capacity of 750,000 tons of electric furnace ingots per year, the plant will consume approximately

575,000 tons of coal, 720,000 tons of iron ore, and 96,000 tons of purchased scrap. The remainder of the scrap (approximately 274,000 tons) is home scrap coming from the open hearth and electric furnaces and from the rolling mills.

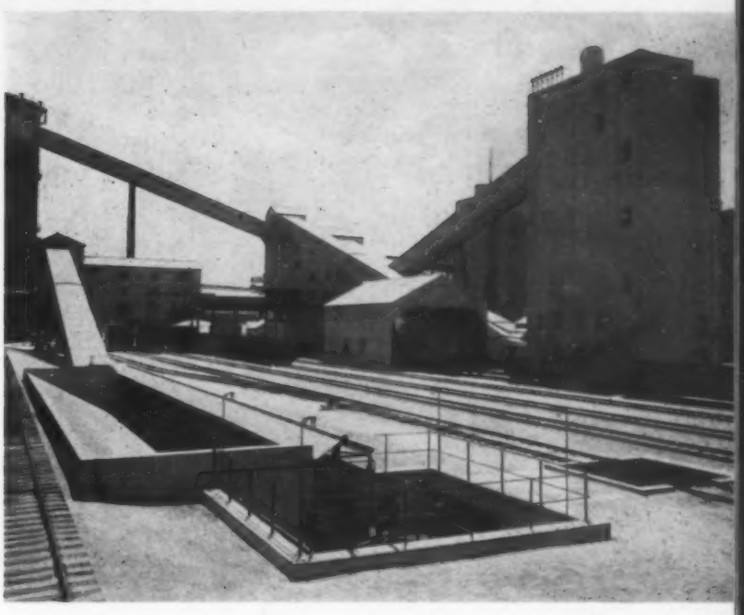
COKE PLANT

Inasmuch as raw materials arrive mainly by boat, it was essential that sufficient storage be provided to carry full operations through the closed season of navigation. Lying along the river is a storage yard 1929 ft long and 300 ft wide. Nominal storage capacity is set at 425,000 gross tons of iron ore, 157,000 net tons of limestone, and 275,000 net tons of coal. Three 17 ton unloading machines and two 15 ton bridges provide adequate facilities for unloading, stocking and handling all incoming materials. A whirler crane is also installed on the dock for handling miscellaneous products into and out of the plant.

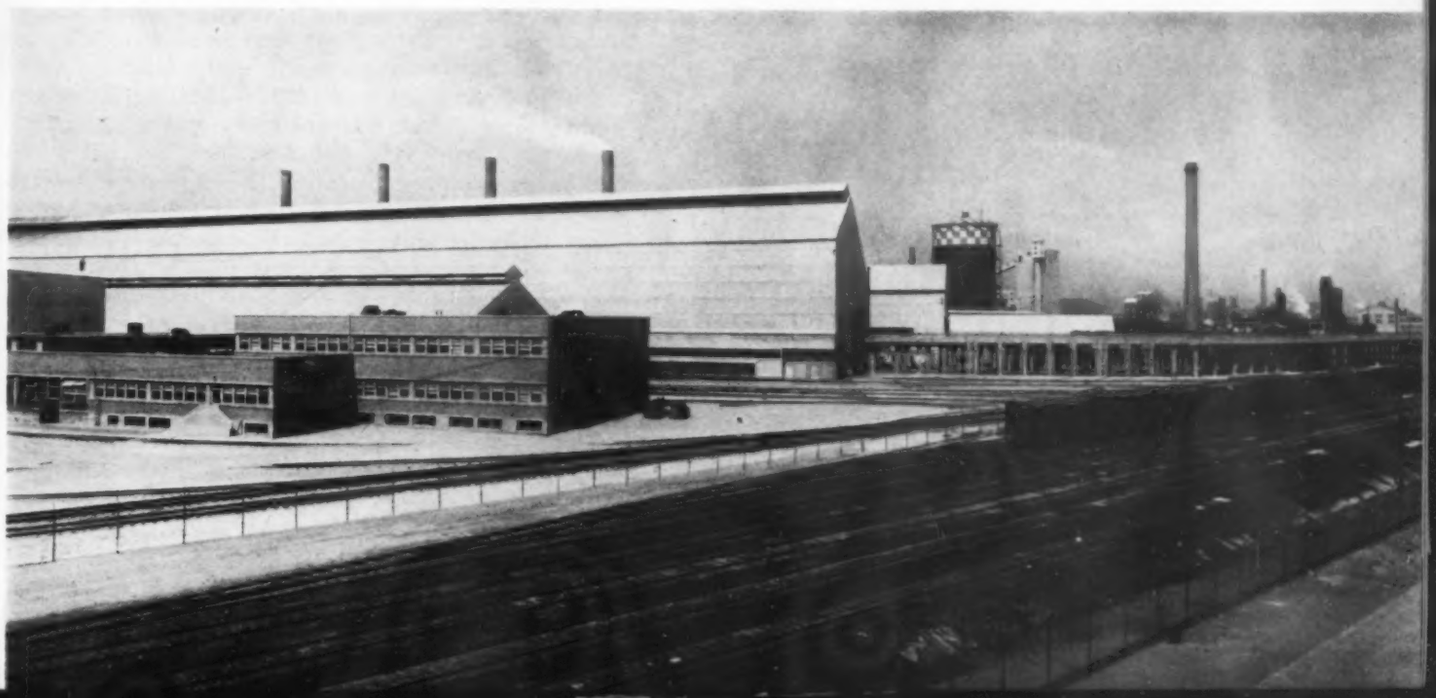
Coal, coming largely from a new mine developed by Republic near Pikesville, Kentucky, may be received either by rail or by water. Rail shipments are dumped into two 14 ft x 40 ft double compartment track hoppers, from where the coal can be moved by conveyors directly to the breaker building or to storage under the ore bridges. Water shipments are usually placed in the storage yard and then moved as needed by the reversible conveyor leading to the breaker building. The coal is processed in the conventional manner at a rate of 300 tons per hr in a breaker and a center feed reversible hammer mill. Crushed to a degree that permits 80-85 per cent passing through a 1/8 in. screen, the coal then passes through mixing bins, feeders and a paddle mixer, where the desired proportions of high and low volatile coals are blended, and is finally conveyed to a 2000 ton reinforced concrete coal bin located over one end of the oven battery and constructed in three bays with four hoppers in each bay. A four-hopper coal charging car, equipped with a scale and traveling at 250-300 fpm, moves the coal from bin to oven.

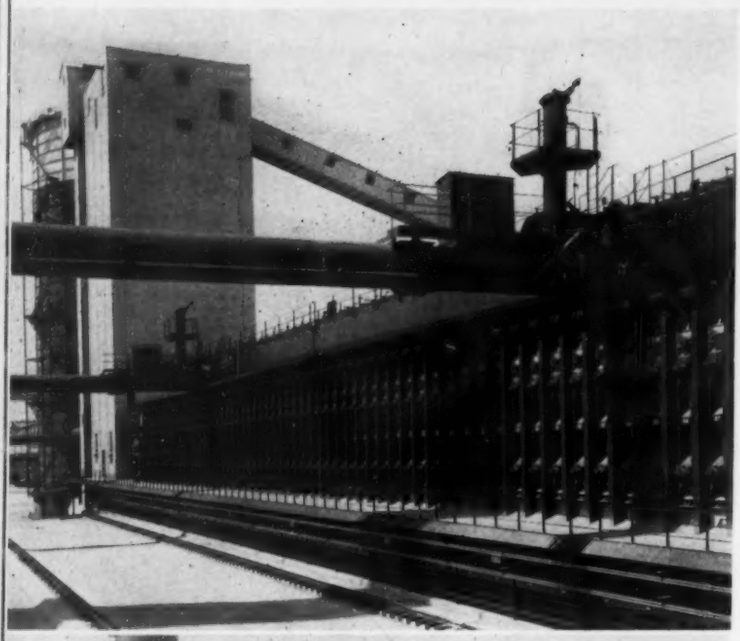
Seventy-five coke ovens, of underjet high-and-low burner, regenerative, low differential design, provide a coking capacity of 1825 tons of coal per day. Each oven is 40 ft 7⅝ in. long between doors, 13 ft 2⅜ in. high, and 16¼-19¾ in. wide. When charged to a nominal height of 12 ft, the 730 cu ft content permits a charge of about 18.25 net tons of coal per oven. At the nominal coking rate of 1 in. per hr, a coking time of 18 hr is obtained. The ovens are designed to be heated by blast furnace gas, although coke oven gas can also be used if desired. Twenty-nine vertical flues in the side walls distribute heat to each oven. Waste gases from the battery are discharged through a single brick stack 275 ft high and 12 ft in diameter at the top. A dry seal fuel gas holder, 89 ft 3 in. in diameter x 182 ft 9 in. high, affords 1,000,000 cu ft of storage for blast furnace gas at a uniform pressure of 12 in. water column. There is also a 20,000 cu ft single lift holder for coke oven fuel gas.

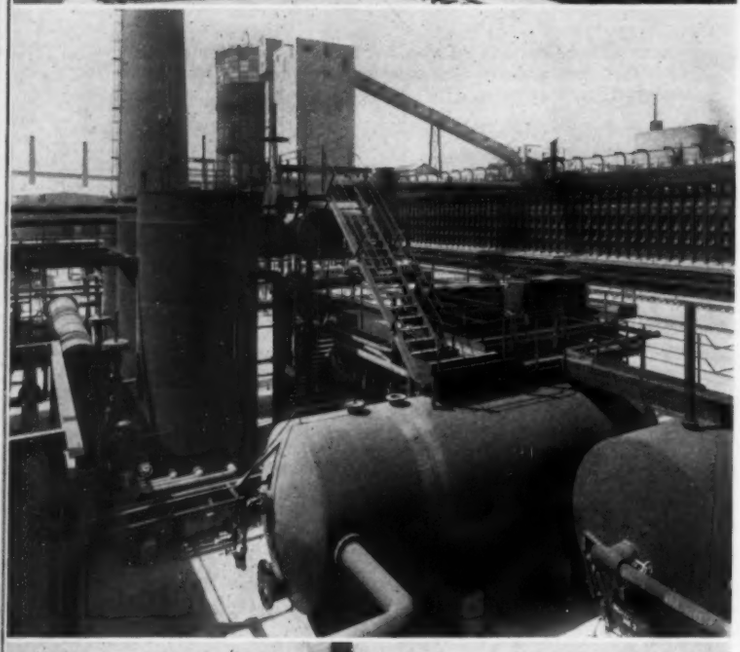
One coke pusher is provided, of 18 ft 9 in. wheel

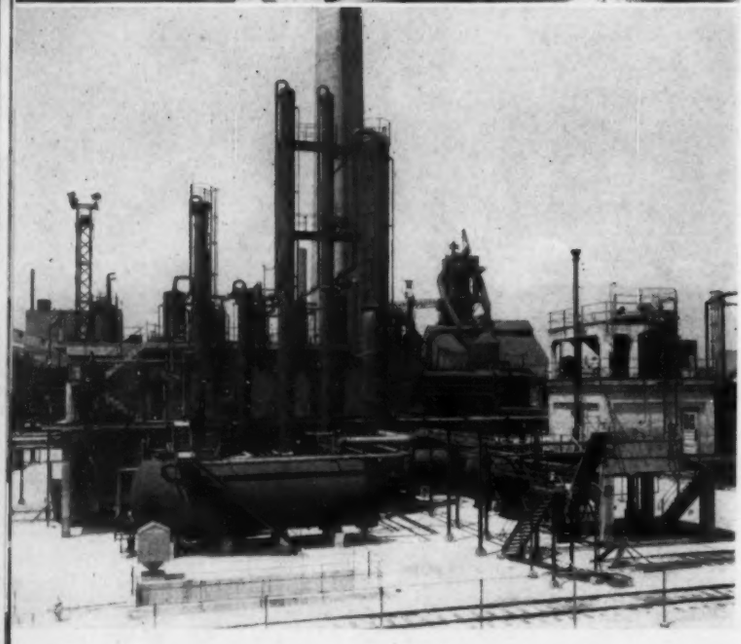


View from the coke side of the oven battery showing the coal crushing and mixing stations and the coke screening station.









(Top) Seventy-five coke ovens of underjet, high-and-low burner design provide a coking capacity for 1825 tons of coal per day.

(Center) View showing flushing liquor decanter with primary coolers in foreground and oven battery in background.

(Bottom) General view of benzol plant, including refining stills, taken from the blast furnace high-line.

base and 28 ft 6 in. rail span. This machine travels at a rate of 275-325 fpm, while the pusher ram moves at 66-95 fpm. The machine also carries a hydraulic door lifter, a leveler bar, and a small air compressor for carbon removal. The coke side door machine is of hydraulic type with swinging head. Full travel of the pull back and door-lift motions require 10-12 sec. Trailer type coke guides with retracting racks are provided.

Coke discharged from an oven is received in a 40 ft quenching car which is moved by a 20 ton electric locomotive to the quenching tower, a 50 ft x 20 ft brick structure 52 ft high, lined with salt glazed vitrified brick. The 10,000 gal overhead quench tank is filled by one of two 1500 gpm pumps.

The quenched coke is dumped on a 135 ft brick-surfaced coke wharf, from where a belt conveyor carries it to the screening station. Here normal practice calls for four sizings: furnace coke, through 3½ in. and over 2 in. screens; nut coke through 2 in. and over ¾ in. screen; pea coke, through ¾ in. and over ¼ in. screens; and breeze, through ¼ in. screen. Each size may be discharged through separate hoppers into railroad cars. Coke to be used in the blast furnace is usually moved by belt conveyor from the screening station directly to the furnace bins. Coke handling equipment has a capacity of 125 tons per hr.

Complete equipment is installed for the recovery of the usual by-products from 2050 tons of coal per day. There are two turbo-exhausters, each with a capacity of 14,000 cfm (19,000 cfm maximum). Electrical precipitators remove tar from the gas.

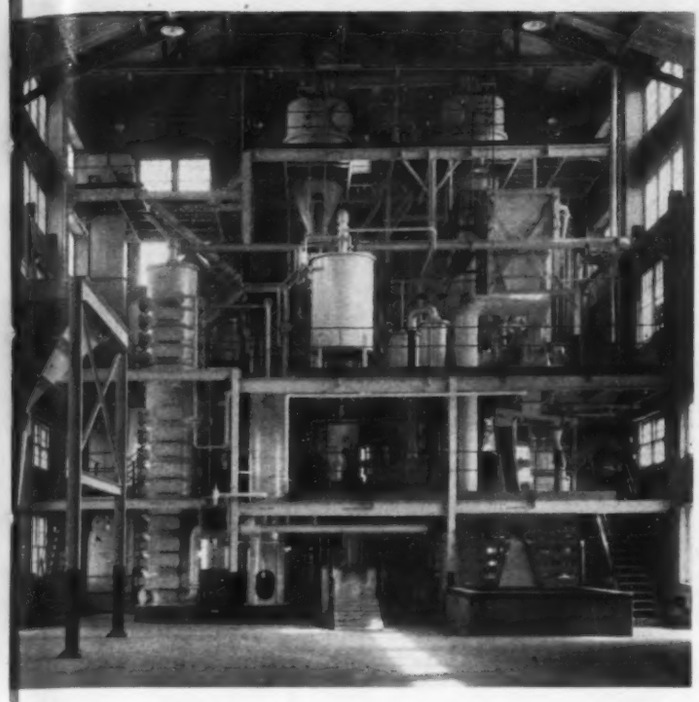
Ammonia is removed from the gas by scrubbing it with weak sulphuric acid in a tower scrubber. Recovery is in the form of large crystal ammonium sulphate.

A wash oil circulation of 17,000 gallons per hr (200 gal per ton of coal) recovers the light oils, which may then be refined into motor benzol, industrial pure benzol, industrial pure toluol, industrial xylol, solvent naphtha, crude heavy solvent and naphthalene.

The gas is purified by soda ash, 90-95 per cent of the H_2S being removed from gas of approximately 475 grains per 100 cu ft initial content.

Equipment is provided for the absorption of phenol from weak ammonia liquor, using light oil, treating the phenolized light oil with caustic soda to form carbolate, decanting the light oil and concentrating the carbolate to a 50 per cent solution for shipment. Equipment is also installed for the recovery of pyridine from the circulating ammonia liquor.

Under normal operation, by-products average about 10,600 cu ft of coke oven gas, 9 gallons of tar, 3.6 gal of light oils, and 25 lb of ammonium sulphate per ton of coal.



General view of the unit for the recovery of ammonium sulphate.

BLAST FURNACE

The blast furnace, which is rated at 1250 net tons per day, has a 27 ft hearth, a 30 ft bosh, and a 20 ft stockline. The total height of 97 ft 7 in. is composed of 11 ft 8 in. crucible height, 12 ft 9 in. bosh height; 7 ft 6 in. straight section; 58 ft inwall section; and 7 ft 8 in. stockline section. The iron notch is located 2 ft 2 in. above the furnace bottom, the cinder notch 4 ft 8 in. above the iron notch, and the tuyeres 3 ft 4 in. above the cinder notch. The bosh angle is 83°-17′-26″, while the inwall batter is 1.0345 in. per ft. The furnace is supported by 9 structural columns.

Brickwork is carried down 18 ft below the furnace bottom to the concrete pad. The furnace lining is 42 in. thick in the crucible, 30 in. thick in the bosh, and 52 in. thick in the inwall section. The stockline section is protected by cast iron wearing plates. Cooling plates are carried up into the inwall section for about one third of its height. Above this, a layer of thermal insulation separates the lining from the furnace shell.

The big bell, 15 ft in diameter, has a slope of 50 degrees. The small bell is 6 ft in diameter. Both bells are operated by pneumatic hoists controlled from motor-operated valves. The double skip is operated by a two-motor drive under constant potential control.

The filling of the blast furnace is governed by a control system governing the filling of the skip car with coke, the starting of the skip hoist, the operation of the revolving distributor, small bell, large bell, stockline recorder, coke screens, coke scales, coke measuring hopper gates, breeze conveyor and breeze hoist.

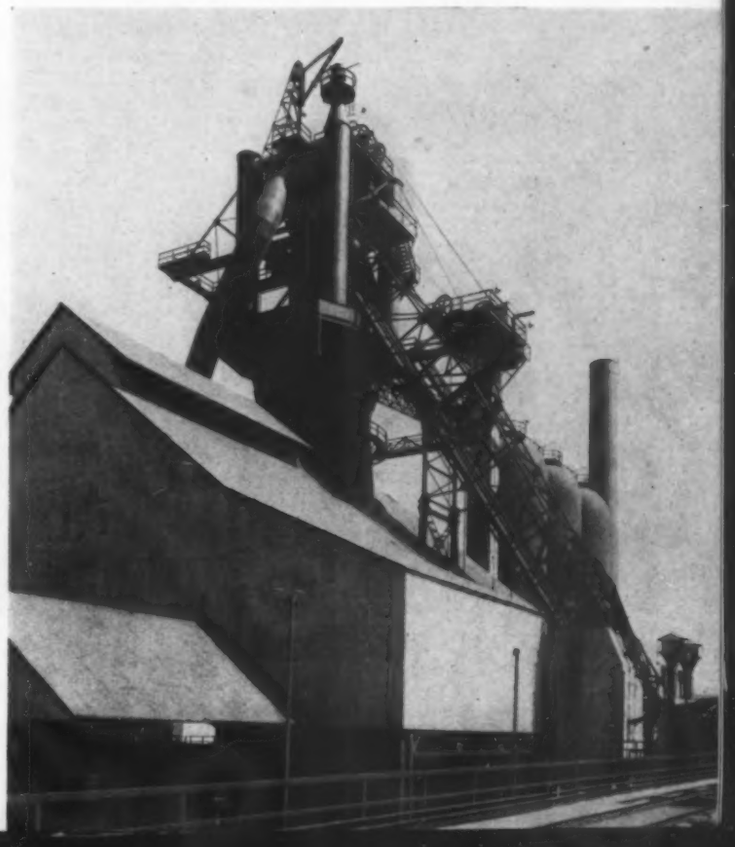
The control for the foregoing equipment is concentrated in four panels located in the hoist house, which is the location of the skip hoist, pneumatic bell hoists and stockline recorders. In the stock house is a master panel equipped with signal lights and push-buttons, by means of which the scale car operator is able to observe the operation of the equipment and initiate the starting of the skip hoist for loads other than coke. Transfer switch equipment is provided so that any portion or all of the furnace charging equipment can be manually controlled, if desired.

Two measuring hoppers are provided which are equipped with scales and so arranged, that coke is automatically screened into them after they have been emptied. The measurement of coke is determined by weight or by volume, as desired. Volume measurement is determined by means of electrodes placed at the top of the measuring hoppers. The coke is charged from the measuring hoppers into the skip car automatically according to a schedule set up by selector switches on the control panel.

The skip is automatically started after being loaded with coke. When the skip car is loaded with ore or stone, it is started by means of a push-button on the scale car master panel. The revolving distributor and small bell are automatically sequenced and programmed to operate in conjunction with the skip. The large bell automatically operates after a selected number of small bell dumps.

The coke breeze from the vibrating screens drops onto a conveying belt which discharges into a receiving hopper for a small breeze skip hoist. When sufficient breeze has collected in the skip car to contact electrodes on the mechanism, the skip car is automatically started, carrying the breeze to a receiving bin where it is dumped, after which the car automatically returns to the loading pit.

Rated at 1250 tons per day, the blast furnace has a 27 ft hearth and is blown through 18 tuyeres.



M. E. GOETZ
District Manager

C. P. CUTLER
Assistant District Manager

A. A. CLAASSEN
Chief Engineer

PAUL JOHNSON, Superintendent, and
JAMES GROVES, Assistant Superintendent,
Blast Furnace and Coke Plant

J. H. ALBAUGH, Assistant Superintendent,
Electric and Tilting Furnaces

R. J. McCURDY
Superintendent, Electric and Tilting Furnaces

Blast furnace stock bins are constructed of reinforced concrete, with gratings, and working parts of steel.

Blast is furnished to the furnace by either of two turbo-blowers, each rated at 90,000 cfm at 30 psi pressure. Blast heating is effected in three stoves, 25 ft x 114 ft 6 in., each containing approximately 210,000 sq ft of heating surface composed of 2 in. flues. An automatic mixer valve provides controlled temperature of the blast going to the furnace. A 4 ft 6 in. bustle pipe distributes hot blast to the 18 tuyeres.

Furnace uptakes are combined into two downcomers 7 ft in diameter leading into a dust catcher 29 ft in diameter. From the dust catcher, blast furnace gas passes through a tower type wet washer and on through two electrical precipitator units.

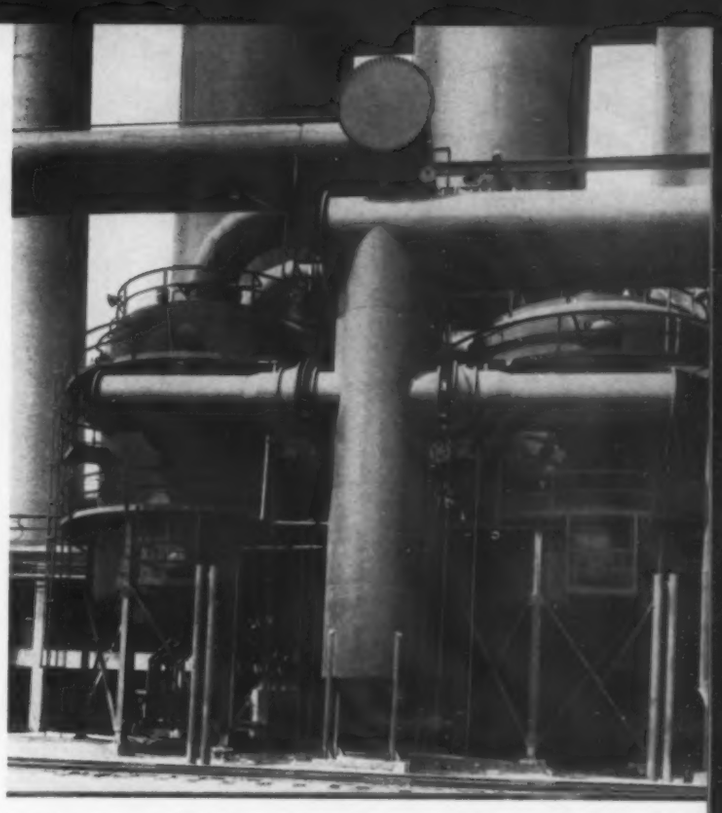
From the cast house, two slag pits extend for a distance of 190 ft. The greater part of the blast furnace slag is tapped directly into these pits, allowed to harden and then loaded by power shovel into trucks or cars. A portion will be processed for the production of lightweight aggregate for thermal insulation.

Dust-laden water (about 3000 gpm from the tower washer and 1000 gpm from the precipitators) flows to a thickening basin 105 ft in diameter, 7 ft 6 in. deep at the sidewalls and 15 ft deep at the center. The motor-driven leveling bar revolves in the settling basin at a speed of $^1/_{18}$ rpm. With the basin's proportions of about 2 sq ft of area per gpm, the overflow from the thickening basin carries not more than 15 grains of dust per gal. Two 3 in. pressure type diaphragm pumps handle the sludge from the thickening basin at rates up to 80 tons of solids per 24 hr.

Located near the blast furnace is a sintering plant designed in accordance with latest developments in this practice. This plant is one of five similar sintering plants installed in various districts of the corporation, with the exception that it has a reinforced concrete building instead of structural steel in order to conserve steel, and also is provided with a disc type filter for receiving sludge from the thickener, this filter delivering the filter cake directly onto the belt conveyor system and thence to the pug mills and the sintering machine.

The sintering machine has 12 wind boxes with an overall length of 89 ft 1½ in. from centerline of the drive shaft to centerline of discharge. The machine has a speed range of 3.4 to 10.2 fpm. The sintering fan is 100,000 cfm capacity, at 24 in. static pressure and is driven by a 600 hp, 720 rpm synchronous motor.

Raw materials are elevated from track hoppers by means of belt conveyor and then charged onto a 5 ft x 10 ft vibrating screen. Provisions have been made for the possible future installation of a spare screen. After screening the raw materials are discharged onto a 30 in. belt conveyor operating at a speed of 260 fpm. This belt conveyor is provided with a tripper which discharges into any one of 5 large capacity storage bins within the sintering plant building. Underneath these bins are provided disc type feeders discharging onto a 30 in. conveyor operating at a speed of 260 fpm. An 18 in. wide conveyor operating at a speed of 180 fpm collects the dust from under the dust catcher and suction main. Raw materials, filter cake and return fines are conveyed to the pug mills by means of a 24 in. conveyor operating at a speed of 260 fpm. Two pug mills are provided and these discharge onto a 24 in.



Electrical precipitator units perform final gas cleaning following a tower type wet washer.

conveyor operating at 260 fpm, and in turn discharges to the swinging spout feeding into the entry end of the sintering machine.

Sintering machine pallets are of cast iron provided with forged steel wheels mounted on tapered roller bearings and provided with grease seals and lubricating fittings for hand grease gun. Special attention was given to the quick replacements of these wheels.

All motors with the exception of that driving the sintering machine and those driving the disc type feeders are 440 volt, 3 phase, 60 cycle. The sintering machine drives and disc type feeder motors are 230 volt d-c. All control panels are located in a dust-tight control room and provided with filtered air which is also piped for cooling the main fan motor. Designed for a capacity of 1000 tons of sinter per day, the sintering machine under normal operation receives about 30 gross tons of coke breeze, 130 gross tons of flue dust from gas cleaning equipment, and 1150 tons of fine iron ore. The product, containing about 60 per cent iron, is distributed approximately 77 per cent to the blast furnace, 18 per cent to the tilting open hearths and 5 per cent to the electric furnaces.

Auxiliary equipment at the blast furnace also includes a stationary wheel pig machine, 160 ft long between sprockets, with 2 ft chain links. Designed with a double strand structure, it is equipped at present with only a single strand which runs at speeds of 10-52 fpm, giving a capacity of 5 tons per minute with 100 lb pigs.

OPEN HEARTH FURNACES

All melting facilities are housed in one building 1470 ft long x 188 ft wide, total for two bays and a leanto.

Bins to accommodate the many alloys used in the furnaces are placed along the floor in the leanto, where two 5 ton floor operated stock bin cranes provide handling facilities. These alloy bins are filled direct from cars spotted on a track just outside the leanto on the stockhouse floor. Four charging machines (three of 7½ ton, one of 5 ton) and a 10 ton overhead charging machine serve both the open hearths and the electric furnaces. Two 150 ton hot metal cranes handle hot metal into the furnaces, and there are also two 25 ton cranes for miscellaneous work.

A totally enclosed stockhouse 1475 ft long and 104 ft wide parallels the melt shop along the charging side. About one-half of the building width (next to the melt shop) is devoted to an elevated floor level with the melt shop floor. Three standard gauge tracks are installed on this floor, with three cross-overs onto the charging floor. Automatic track scales are installed in these tracks to weigh the cars as they pass over. The low level ground floor is devoted to storage of scrap as well as limestone, burnt lime, dolomite, ore, fluorspar, roll scale, loam, etc. Chutes carry the latter materials from the high level to their respective bins on the lower level. Three 15 ton cranes with center cabs handle the various materials, which are placed directly into the charging box drag on the upper floor level.

Four tilting open hearth furnaces, each 250 tons holding capacity, receive the hot metal of known analysis, which is brought from the blast furnace in five 150 ton bottle type hot metal cars and poured into hot metal ladles. With a 70 per cent hot metal charge, these furnaces oxidize out the impurities, preparing a molten steel which can be tapped off for electric furnace charges as it is needed. Thus, the iron from the blast furnace need not be low in phosphorus. In fact, the plant is designed metallurgically to handle as high as .90 per cent phosphorus in the iron, although .30-.35 per cent prevails at present.

Production from the four open hearth furnaces averages about 1600 tons per day.

The open hearth furnaces, with hearth dimensions of 14 ft 6 in. x 42 ft, are each composed of a tilting section mounted between two stationary port sections. The tilting section, 54 ft long between the water-cooled chills at each end, is carried on three longitudinal box section girders which are supported by two cast steel rockers 24 ft apart and of 15 ft 6 in. radius. The rockers in turn bear on rollers, so that, through the action of two screw drives driven by two 100 hp motors, the furnace may tilt through a range of 28 degrees forward for tapping and 12 degrees backward for slagging.

Five doors, 3 ft 6 in. high x 5 ft 3 in. wide, are spaced on 8 ft 8 in. centers along the charging side of the furnace.

Each port section is 20 ft long, and so constructed that the port castings form a rigid binding for the ends of the ports and also give suitable support for the chills and water cooled parts. There is a 3 in. space (more or less) between the ports and the tilting section of the furnace.

Single slag pockets on each end are 10 ft 6 in. x 28 ft 9½ in. x 16 ft 7½ in. high. On each end of the furnace there are two regenerator chambers, 10 ft wide x 25 ft long and containing special checkerwork to a depth of 12 ft 3 in. Both chambers are at present used for preheating air.

A fire-tube waste heat boiler is installed in connection with each furnace. Forced and induced draft is provided by suitable fans, and waste gases are disharged through brick stacks 175 ft high and 7 ft 6 in. in diameter.

Water-cooled combination burners introduce fuel oil and coke oven gas through each end of the furnace. Complete furnace control equipment offers control of furnace pressure, gas flow, oil flow, air flow, atomizing steam and furnace reversal on a time cycle.

The open hearth was inserted in the production cycle of this plant in order to provide for the electric furnaces a low phosphorus charge of a known analysis — a material difficult to obtain with the prevailing scarcity of scrap. At the same time, the molten charge decreases the time of heat in the electric furnaces, thus increasing their productive capacity. This method had already been proven in the Canton, Ohio, plant of Republic, where molten open hearth metal was in use as an electric furnace charge.

Paralleling the melt shop is an enclosed stockhouse with two floor levels, providing storage for scrap, dolomite, limestone, burnt lime, fluorspar, etc.

Four 250 ton tilting open hearth furnaces prepare a molten steel which is tapped off as needed for electric furnace charges.

View of a tilting open hearth from the tapping side. This furnace has hearth dimensions of 14 ft 6 in. x 42 ft.

Again because of scrap shortage, the use of a high iron charge to the open hearth appeared necessary. Inasmuch as high iron charges require slag flushing, particularly with high phosphorus, high sulphur iron, the tilting type of open hearth seemed particularly desirable.

The hot steel tapped from the open hearths is low in phosphorus, sulphur and silicon, somewhat higher (about 10 points) in carbon than the product to be made in the electric furnace, and sufficiently hot to prevent freezing on the bottom of the arc furnace. The molten steel is usually charged into the electric furnace through the charging door, using a brick lined spout just as in charging hot metal into the open hearths.

ELECTRIC FURNACES

In line with the open hearth furnaces are 9 tilting basic arc furnaces, with shells of welded construction 20 ft diameter and 11 ft high, and capable of taking a charge of 80-90 net tons. The hearth of the furnace is built up of rammed magnesite material, side walls, 18 in. thick, are of metal-encased magnesite brick and the roofs are of 12 in. silica brick. Roof life averages about 35 heats, while the basic side walls last for about 200 heats.

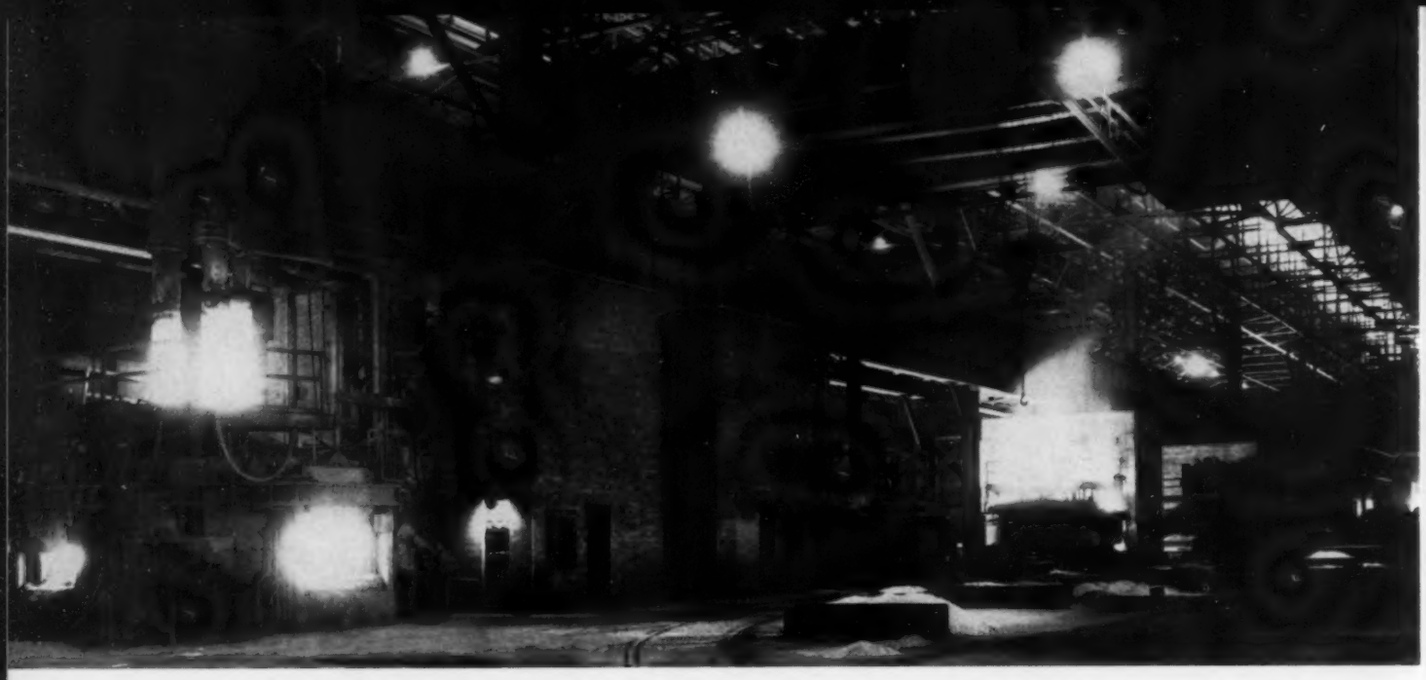
The furnace rests upon a double rocker of 14 ft 9 in. radius and is tilted through an arc of 40 degrees forward, 18 degrees backward through crank action by a 33 hp d-c motor. The rockers have been spread apart sufficiently (13 ft 6 in.) so that the slag ladle can pass under the furnace from the pouring pit to the back for slagging off. A brick enclosure is placed around the slag ladle to keep splashes or spills out of the furnace cellar. A slag apron beneath each furnace protects the tilting mechanism from slag.

Water cooling is applied to the furnace doors, door jambs, door frames, electrode glands, electrode holders and bus tubes.

Power is introduced to the furnace through three 20 in. graphite electrodes spaced around an electrode circle of 5 to 5½ ft diameter. Flexible lead cables, each phase consisting of thirty-two 1,750,000 circular mil cables, connect the furnace to the transformer leads. Furnace transformers are of 12,500 kva capacity, oil immersed, water cooled, 12,000 volt primary. Five of the transformers have external steel-tubed heat exchangers, dictated by wartime scarcities. Transformer taps may be selected so as to obtain seondary voltages of 275, 260, 245, 230 and 215 with full capacity, and 200 and 185 with reduced capacity, all with the primary connected in delta, and correspondingly lower voltages (58 per cent) with the primary in Y-connection. With a secondary voltage of 275, inherent reactance of the transformer is 4½ — 5 per cent. Furnace control consists of balanced arm regulators.

A motor operated no-load tap changer affords an immediate choice of five voltages, three on delta connection and two in Y-connection, giving a sufficient range for the requirements of melting and refining the heat. The tap changer is mounted in oil in a separate compartment bolted to the side of the transformer tank.

Metal cubicles house removable draw-out three pole, single throw air circuit breakers, rated at 15,000 volts, with an interrupting capacity of 250,000 kva at 12,000



Nine tilting basic arc furnaces, with shells 20 ft in diameter, produce the finished steel. Each furnace is provided with a 12,500 kva transformer.

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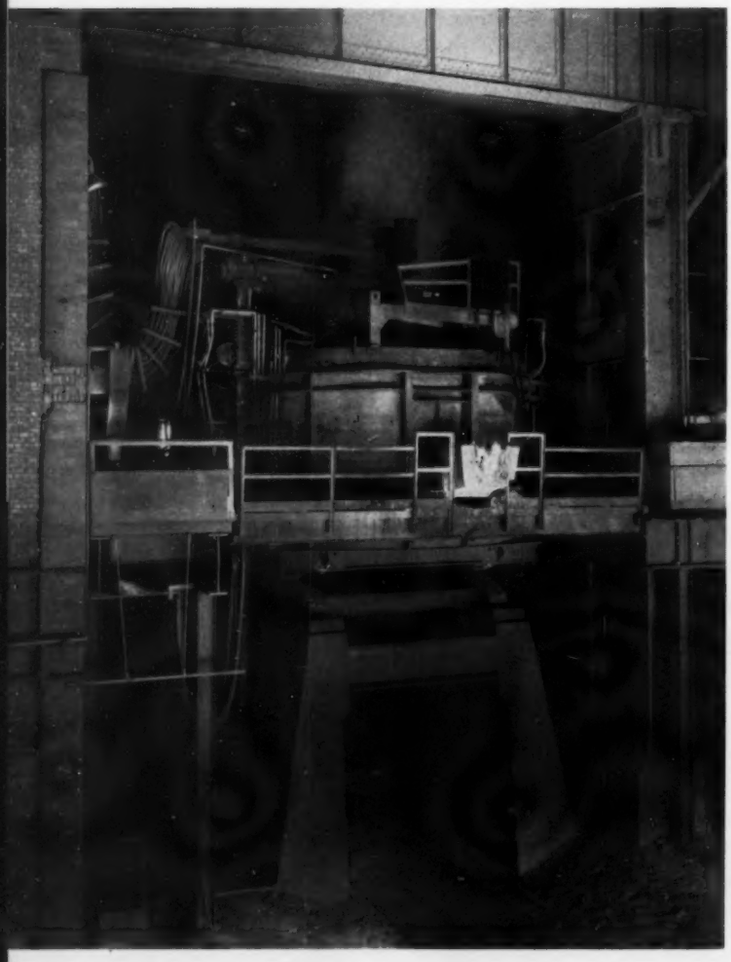
Furnace foundations have been so designed that a slag ladle on a car can pass under the furnace from the pouring pit for convenience in slagging off.



volts and a one second rating of 50,000 amp. Motor-operated disconnect switches are rated at 1200 amp, 15,000 volts. These air breakers are intended only for operating purposes and are backed up by oil circuit breakers located out in the main substation and intended for overload protection.

When operating with cold charges, the time of heat averages about 9.8 hr, tap to tap. The time between heats averages 1.1 hr for repairing bottom and charging. A production rate of 8.4 tons per furnace hr is maintained, and power consumption is about 570 kwhr per ton of ingots. Electrode consumption averages approximately 11 lb per ton of ingots. With hot metal charges, time of heats ranges 4-5 hr, power consumption is about 300 kwhr per ton, and electrode consumption is 5-6 lb per ton. Molten steel from the open hearths is sufficient for only about 70 per cent of the electric furnace charge. The remainder of the charge material is home scrap. However, hot and cold charges are not mixed in the same furnace. Electric furnace charges are either molten steel or cold scrap.

Double slag practice is generally used on both cold and hot charges. Approximately 45 lb of limestone is used per ton for the oxidizing slag, with 50 lb of burnt lime per ton being used for additions and for the second slag. Consumption of other fluxing materials includes 11 lb of fluorspar, 10 lb of coke and 3 lb of silica sand per ton of ingots. Bottom patching consumes about 40 lb of roasted dolomite, 4 lb of grain magnesite and one lb of chrome ore per ton of ingots.

Crane facilities in the pouring pit include two 300 ton ladle cranes, three 150 ton ladle cranes, all with auxiliary hoists, and one 10 ton repair crane. Two transfers permit the moving of hot open hearth metal from the pouring pit bay to the charging floor bay, where the ladles may be reached by the hot metal cranes for transportation to the electric furnaces. A control chemical laboratory is located on the melting floor level near the electric furnaces. A spectrograph is installed here for rapid determination of residual alloys in both open hearth and electric furnace melts. The floor laboratory is connected to the main chemical laboratory by pneumatic carrier tubes and by telautograph.

Ingots are teemed either directly or by double pouring, according to metallurgical specifications. Three sizes of ingots were planned to cover the entire product range of the plant: 20 in. x 23 in. x 80 in., 7000 lb; 25 in. x 25 in. x 80 in., 10,000 lb; and 35 in. x 35 in. x 143 in., 34,160 lb. All of these are hot-topped, big-end-up type, for killed steels. Moulds are usually heated to 250-300 F and sprayed with powdered corn sugar (about one pound per mould) which melts into a glazed coating. Mould preparation is carried on in a special building 132 ft wide x 454 ft long, provided with three 15 ton cranes and two mould dumpers. A platform 25 ft wide extends the length of the building, providing access to the tops of the moulds for spraying, setting the hot tops, etc.

Two 200 ton push-pull type overhead strippers of 63 ft span, with 15 ton auxiliary hoists, are located in the stripper building, which is 254 ft long x 71 ft wide.

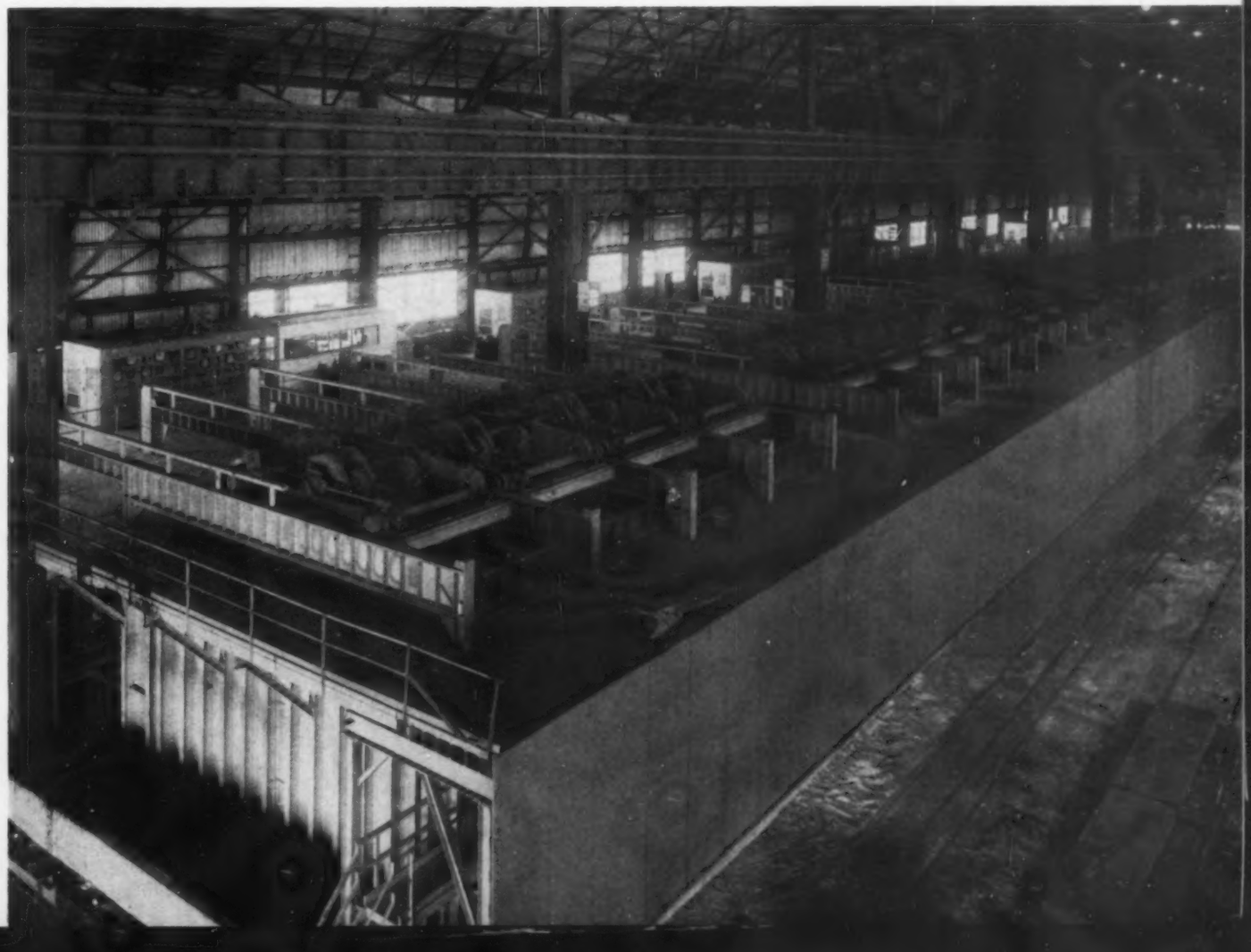
Slag from the melting operations is taken in the ladles to the slag building, 83 ft x 300 ft and equipped with one 15 ton and one 30/15 ton crane. Here the slag is dumped and broken up with a drop ball. Recoverable scrap is reloaded by magnet and returned to the open hearth stock house. Refuse is loaded by bucket into railroad cars and removed to the dump. About 5000 tons per month of open hearth slag is charged into the blast furnace.

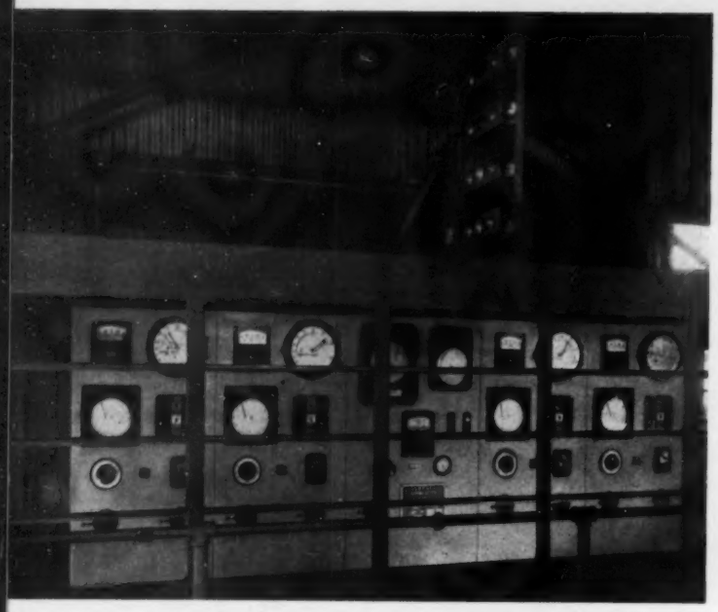
BLOOMING MILL

Ingot heating facilities consist of six rows of one-way fired recuperative soaking pits of four holes each. Each hole, 8 ft 2 in. wide x 25 ft long x 14 ft deep above the coke bed, is provided with a silicon-carbide tubular recuperator to heat combustion air to a temperature of 700 F, the air being drawn through the recuperator by a blower rated at 31,000 cfm, 3½ in. water column at 700 F. Coke oven gas or a mixture of natural gas and air of 550 Btu per cu ft is introduced through a single burner near the top of one end wall, the flame traveling out over the tops of the ingots, turning down and moving back around the ingots to flue openings located near the bottom of the same end wall. A brick stack 125 ft high vents waste gases from each row of pits. Each pit is designed to take twenty 20 in. x 23 in. ingots, sixteen 25 in. x 25 in. ingots, or five 35 in. x 35 in. ingots. The unusual depth of these pits was dictated by the length of the large 17 ton ingots, as well as the necessity of some "saddening" operations.

Based on alloy steel ingots with 2½ hr track time, heating times are tentatively set at 8 hr for 20 in. x 23 in. ingots, 10 hr for 25 in. x 25 in. ingots and 20 hr for 35 in. x 35 in. ingots, one-third of this time being devoted to heating and two-thirds to soaking. Complete control equipment affords automatic regulation of fur-

Soaking pits, 8 ft 2 in. wide x 25 ft long x 14 ft deep, are of recuperative design and fired with coke oven gas or a mixture of natural gas and air.





Each block of pits has a central panel board providing automatic control of furnace temperature, furnace pressure, fuel-air ratio and preheated air temperature.

nace temperature, furnace pressure, fuel-air ratio and preheated air temperature.

Ingots are handled into and out of the pits by 15 ton stiff leg pit cranes. Heated ingots up to 17,600 lb in weight are placed in a side-dump ingot buggy which travels the length of the pit furnace building at speeds up to 650 fpm and conveys the ingot to the mill table. The larger ingots are conveyed directly to the table by pit crane.

The building housing the soaking pits makes an oblique angle with the mill building because of the shape of the plant property. Hence, the first table unit is a skew table 14 ft long with 7 rollers 54 in. long, 18 in. in diameter at the small end and 21 in. in diameter at the large end. Following the skew table is the ingot delivery table and mill approach table.

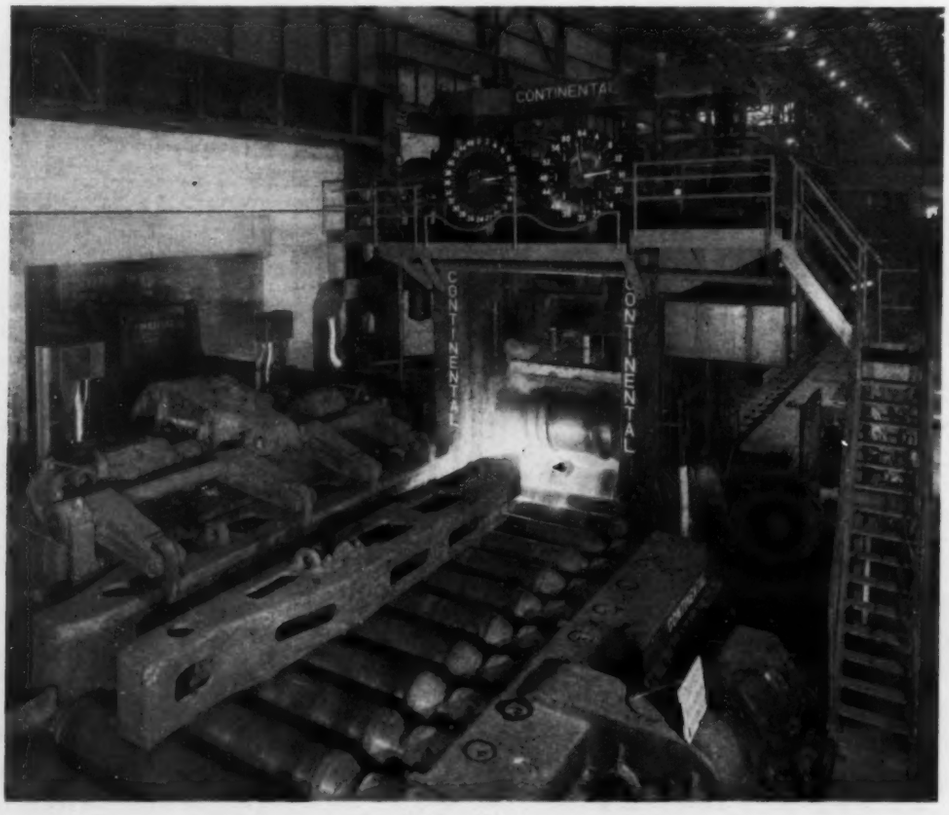
The primary blooming mill is a 44 in. two-high reversing unit, with closed top type housings mounted on cast steel shoes which are in turn mounted on heavy cast steel cross ties. The housings, with each post offering an area of 550 sq in, are tied together by cast steel separators and rolled steel tie rods. Two cast steel cylinders are mounted directly in the roll housings and support an overhead cross beam from which hang steel suspension rods connected to the top roll carriers. This roll balance is operated by a 500 psi hydraulic system which contains an accumulator of the ballast type, 24 in. in diameter with a 9 ft stroke. The rolls are 96 in. body length and run in composition roll neck bearings.

Mill screws, 15 in. in diameter with a 2 in. pitch, and driven by two 150 hp motors, operate in high-tensile bronze screw boxes, giving a maximum top roll lift of 46 in. at a maximum lifting speed of 25 fpm. The entire screwdown mechanism is equipped with roller bearings. Two large dial indicators, calibrated in inches and sixty-fourths, respectively, show the roll position.

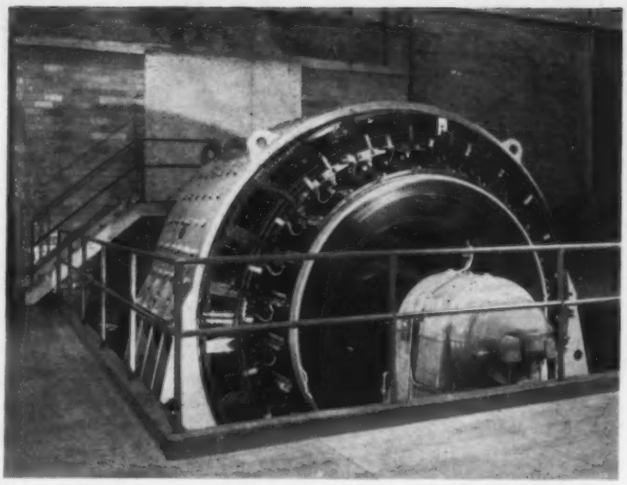
Two solid forged steel feed rollers, 20 in. in diameter, are mounted in each side of the mill housings, each pair driven by a 50 hp d-c mill motor. Front and back mill tables are 32 ft 8 in. long, composed of 15 rollers, 20 in. x 106 in., on 2 ft 4 in. centers, each table being driven by two 150 hp motors.

Rolls may be changed, one at a time, by means of a rack type roll changing rig through the housing window which is 4 ft, 2 in. wide.

Two rack operated cast steel side guards 27 in. high are provided on each side of the mill, driven by four 150 hp d-c mill type motors so as to give a maximum



The 44 in. reversing blooming mill uses rolls of 96 in. body length, running in composition bearings and hydraulically balanced.



The 44 in. mill is driven by a 7000 hp motor (above) which receives power from four 2000 kw generators (below).

A hot scarfing machine is placed in the blooming mill line, designed to desurface four sides of the blooms or slabs at one time. (below).

speed of 100 fpm. Tilting fingers, on the entry side only, operate at 30 strokes per min, driven by 75 hp motors.

Mill pinions are of cast alloy steel, 44 in. pitch diameter and 66 in. face, with 20 double helical cut teeth. An individual 2000 gal circulating oil system provides lubrication for the teeth and babbitt bearings of the pinion set.

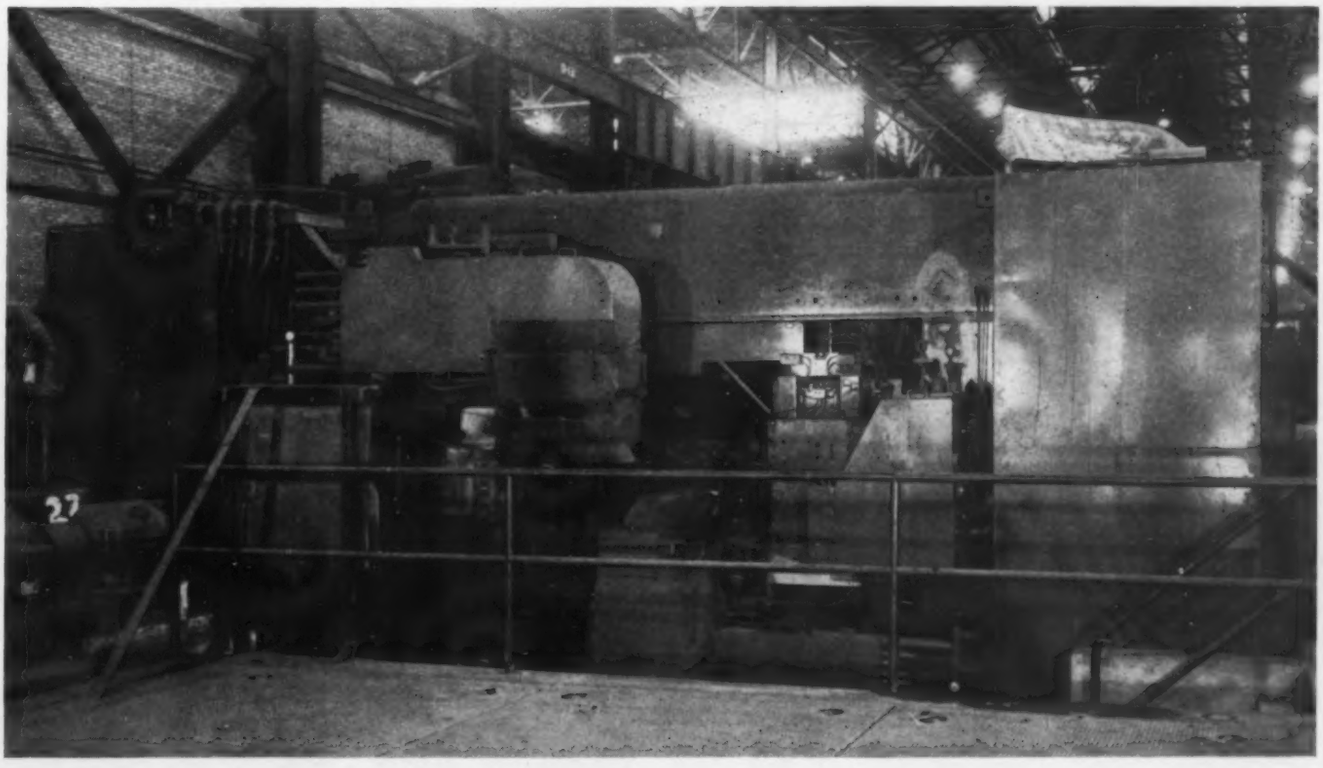
The mill is driven by a 7000 hp, 40-100 rpm, 700 volt motor, which receives power from a motor-generator set consisting of four 2000 kw generators driven at 514 rpm by a 5500 hp, 6600 volt wound rotor motor. The generators are shunt wound, compensated with differential and cumulative series fields for load balancing. The set carries a steel plate flywheel 146 in. in diameter, of 24 in. face, and is controlled by a liquid slip regulator.

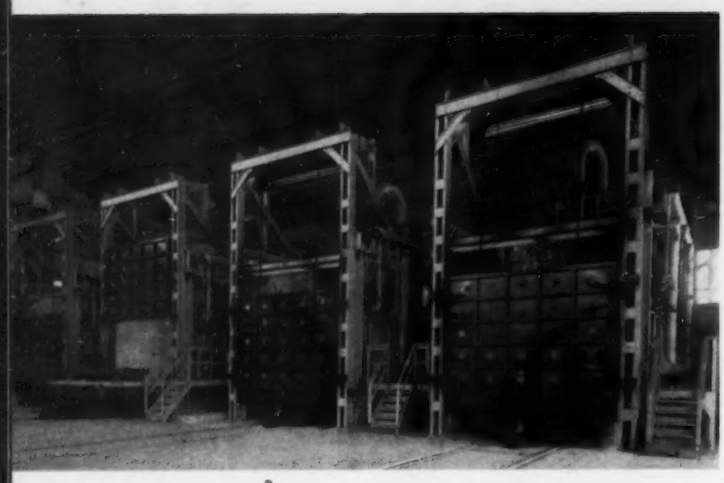
The exciter set consists of a 125 kw unit for the reversing motor, a 125 kw unit for the four generators, a 45 kw dynamic braking set and a 200 hp drive motor. A pilot exciter set is also used in the reversing motor control, so designed that generator voltage is controlled by a pilot exciter which controls an exciter connected to and supplying excitation for the generator fields. Motor field excitation is supplied from another exciter connected to the field and also controlled by a pilot exciter. The mill master switch is used to control the pilot exciters so that generator voltage and motor field strength are varied as required to fill the requirements of the reversing service.

Auxiliaries of the 44 in. mill operate under variable voltage control, their drives receiving power from two 6-unit motor generator sets:

One 150 kw unit for manipulator racks.
One 150 kw unit for mill tables.
One 350 kw unit for bloom shear.
One 150 kw unit for screwdown.
One 50 kw unit for feed rolls.
One 1000 hp, 1200 rpm, 6600 volt synchronous drive motor.

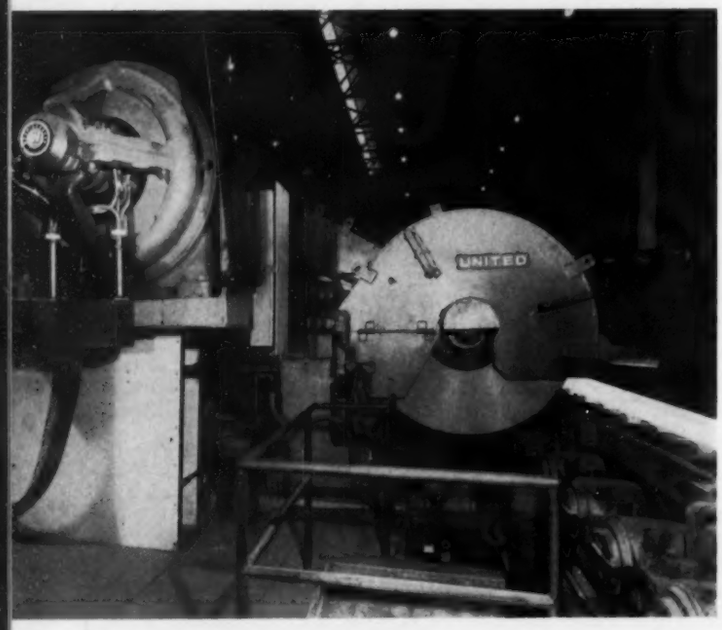
These variable voltage units are differentially compounded and are controlled by two 5-unit pilot exciter sets.





Car type furnaces are used for slow-cooling large blooms.

A 72 in. hot saw with 5 ft stroke is installed in the blooming mill line.



All of the foregoing drive equipment is located in the 44 in. mill motor room, as is the necessary switching and control equipment, one 1500 kva auxiliary motor-generator set and a 2000 kva transformer bank. All rotating equipment is ventilated by a down-draft recirculating system, which also supplies cool air to the mill auxiliary drives operating under variable voltage. Control equipment is, for the most part, mounted on slate panels which were assembled and wired at the factory.

Following the 44 in. mill at a distance of 93½ ft is a hot scarfing machine, designed to simultaneously desurface four sides of stock ranging from 7 in. to 14 in. square or slabs up to 16 in. wide x 14 in. thick. The machine operates at speeds of 70-200 fpm, and takes a cut $\frac{1}{32}$-$\frac{1}{8}$ in. deep. A hood and stack are installed to remove smoke and fumes from the machine, and water jets at a pressure of not less than 100 psi remove the slag. A cycle of 38 sec per bloom, including positioning, may be maintained. Consumption of oxygen and acetylene depends on the speed of the stock through the machine and the number of nozzles used which varies with the size of the stock.

The large ingots are usually rolled to 18-24 in. blooms and are removed from the mill table by overhead crane immediately following the scarfing machine, being placed on a transfer car which carries them to an adjustable oxy-acetylene cutting station for cropping, and then to burial pits for slow cooling. Seventeen pits 72 ft x 10 ft and eight pits 48 ft x 10 ft provide coverage for 64 heats of large gun blooms, and allow a cooling cycle of as much as 20 days. Four car type cooling furnaces are also installed for large blooms, using a cycle of 10-13 days. Seven burial pits, 60 ft x 8 ft x 8 ft, with movable partitions, will cover 28 heats of small gun blooms, where the cooling cycle approximates 14 days. All of these pits are above ground.

After the cooling cycle, gun blooms are sorted, tested, chipped and shipped.

About 56 ft along the mill line from the scarfing machine is a 1000 ton bloom shear, of downcut, start-stop design. This shear is driven by two 350 hp d-c motors under variable voltage control, and is capable of cutting product up to 14 in. x 16 in. There is a motor-operated retractable chute at the lower knife of the shear for receiving test pieces and depositing them at the outside of the shear frame. A shear gauge of single screw type, measures bloom lengths up to 21 ft. The maximum bloom size which can be cropped on the shear is 14 in. x 16 in. Crop ends are conveyed directly into crop cars.

A 72 in. hot saw of 5 ft stroke is also installed, with a knife head type gauge for lengths up to 21 ft. Test piece chutes are placed at each side of the saw blade.

BAR MILL

Following the hot saw in the mill line is a push-off which moves blooms from the mill table on to a bloom transfer running at right angles to the table, over which

A chain type transfer carries steel from the blooming mill table to slow-cooling pits or to the charging table of reheating furnaces.

L. A. WYND
Electrical Superintendent

R. S. LAVETTE
Superintendent of Mills

G. B. McKEE
Master Mechanic

C. W. BARRETT
Superintendent of Roll Design

A. G. FORREST
Chief Metallurgist

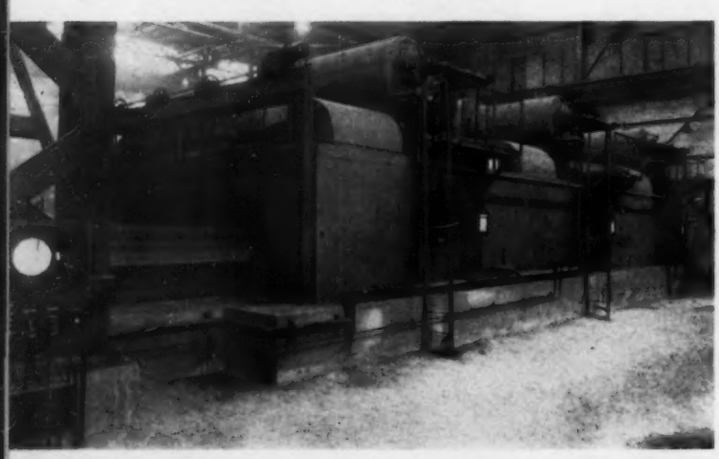
R. I. PISLE, Superintendent
Industrial Relations

An unusual number of slow-cooling pits are installed, dictated by the grades of steel for which the plant was designed A transfer car carries steel from the chain transfer to the pits.

material intended for further rolling is usually moved. This transfer, which is about 225 ft from the 44 in. mill, consists of two sections of 5-strand chain conveyor. The first section, 86 ft 6 in. long x 17 ft 2 in. wide, is of bar type chain with stationary dogs at 12 ft spacings, while the second section is 46 ft long. The two sections overlap each other 10 ft to permit the gathering of billets if desired. This overlap is in line with the charging table of the reheating furnaces, so that blooms may be run off the transfer for direct charging into the furnaces should the nature of the product permit this practice.

The bloom transfer discharges on to a transfer car which runs the length of an installation of burial pits consisting of 50 slow-cooling pits below ground, 50 ft x 8 ft x 8 ft, with movable partitions. A coverage of 150 heats is thus provided, giving, with normal operations, a possible cooling cycle of as much as 7 days. After cooling, blooms for rerolling are sorted, tested and shipped or scarfed. A pusher type preheating oven, 22 ft. 8 in x 60 ft, may be used to raise the temperature of cold blooms to about 600 F before scarfing, should the grade of steel require it. Swing frame grinders are installed for surface conditioning of grades of steel that may not be chipped or scarfed. Four pickle tanks, 72 ft x 6 ft, and a rinse tank, 25 ft x 6 ft, provide facilities for pickling part of the bloom before conditioning.

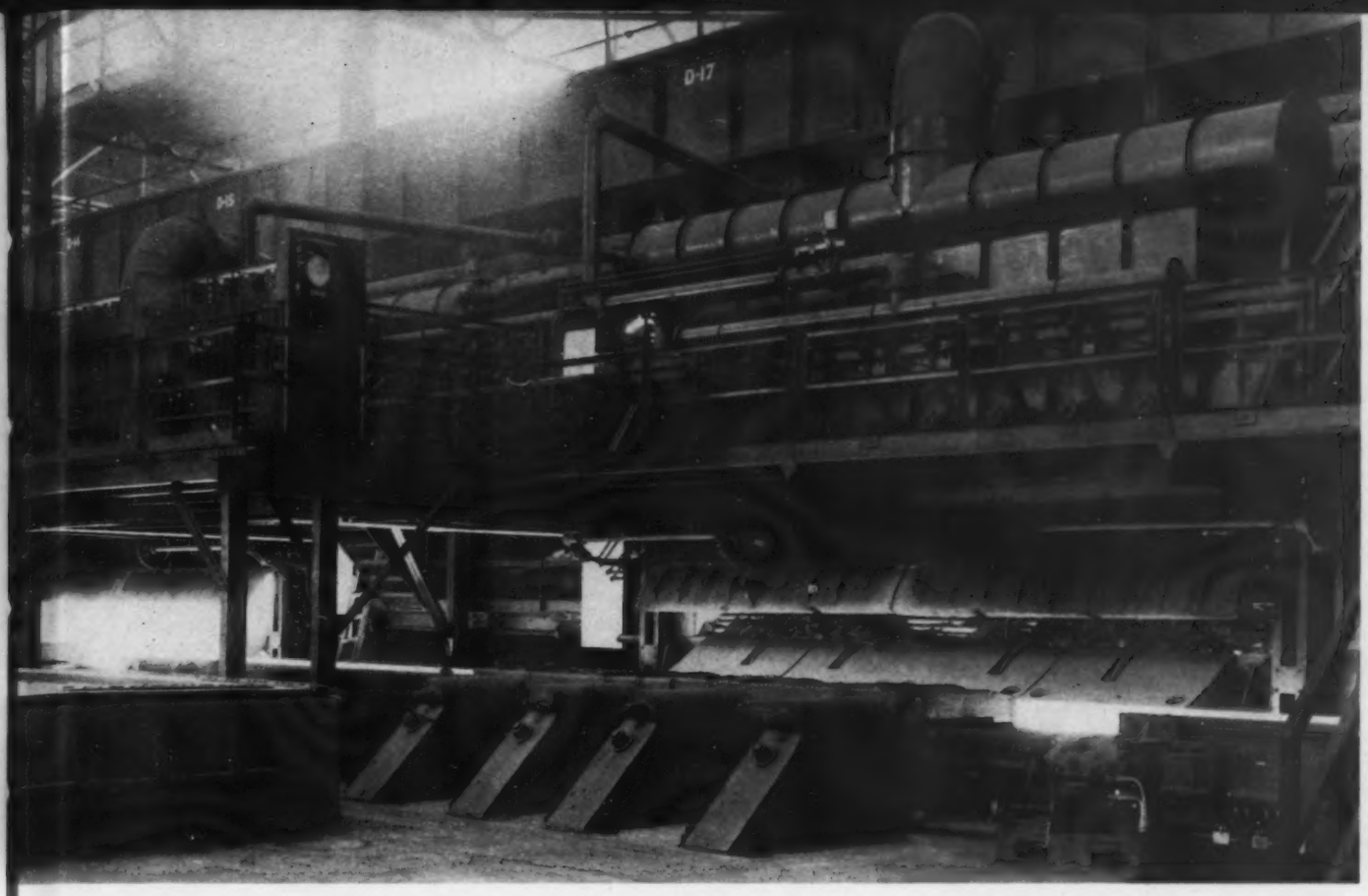
A continuous convection oven is provided to preheat cold blooms if necessary before scarfing.



Reheating facilities consist of two continuous triple-zoned furnaces, with hearth dimensions of 22 ft x 70 ft. Of this length, 13 ft 6 in. is taken up by a soaking zone, top fired with gas through 8 burners. Six combination gas-oil burners are installed in the top heating zone and six more in the bottom heating zone. Air for combustion is preheated to about 600 F in tubular silicon-carbide recuperators. A fan rated at 40,000 cfm at 3½ in. water column and 600 F pulls the air through the recuperator. Automatic control is supplied for fuel-air ratio, furnace pressure, soaking zone temperature, and recuperator temperature. Waste gases are discharged through a 150 ft brick stack.

Each furnace is estimated to have a capacity of 65 net tons per hr of 14 in. x 14 in. carbon steel blooms or 52 tons per hr of similar alloy stock, with a fuel consumption of about 1,500,000 Btu per ton.

In charging cold blooms (which is the usual practice), the material is placed on a central charging table, from which it is pushed forward on to the furnace charging table, 89 ft 7 in. long, running across the back end of the reheating furnaces. The bloom is then carried on the



Two continuous triple-zoned furnaces reheat steel for rolling in the secondary mills. Fired with gas or oil and with hearth dimensions of 22 ft x 70 ft, each furnace is rated at 65 tons of cold carbon steel per hr.

charging table to the desired furnace, where rack type pushers move it into the furnace.

Under the action of the furnace pushers, the reheated bloom is discharged from the front end of the furnace and then moved over tables to the secondary mills.

Roughing of rerolled material is accomplished in a 36 in. two-high reversing mill, with cast steel open top housings, located in line with and 437 ft beyond the 44 in. mill. The rolls in this stand are 36 in. x 82 in. with 22 in. diameter necks operating in composition bearings. The top roll is balanced by counterweights, and has a maximum lift of 20 in. Mill screws are 11 in. in diameter with 1¾ in. pitch, and both screws are operated by a single 150 hp motor so as to obtain a roll lift speed of 10.46 ft per min.

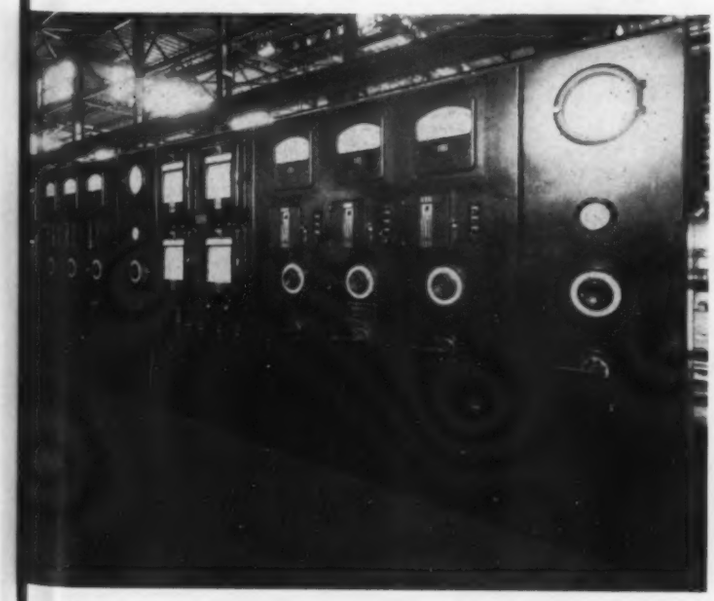
On each side of the mill are two movable side guards, one of each pair carrying tilting fingers. Four 100 hp motors drive the sideguards, and four 50 hp motors actuate the tilting fingers.

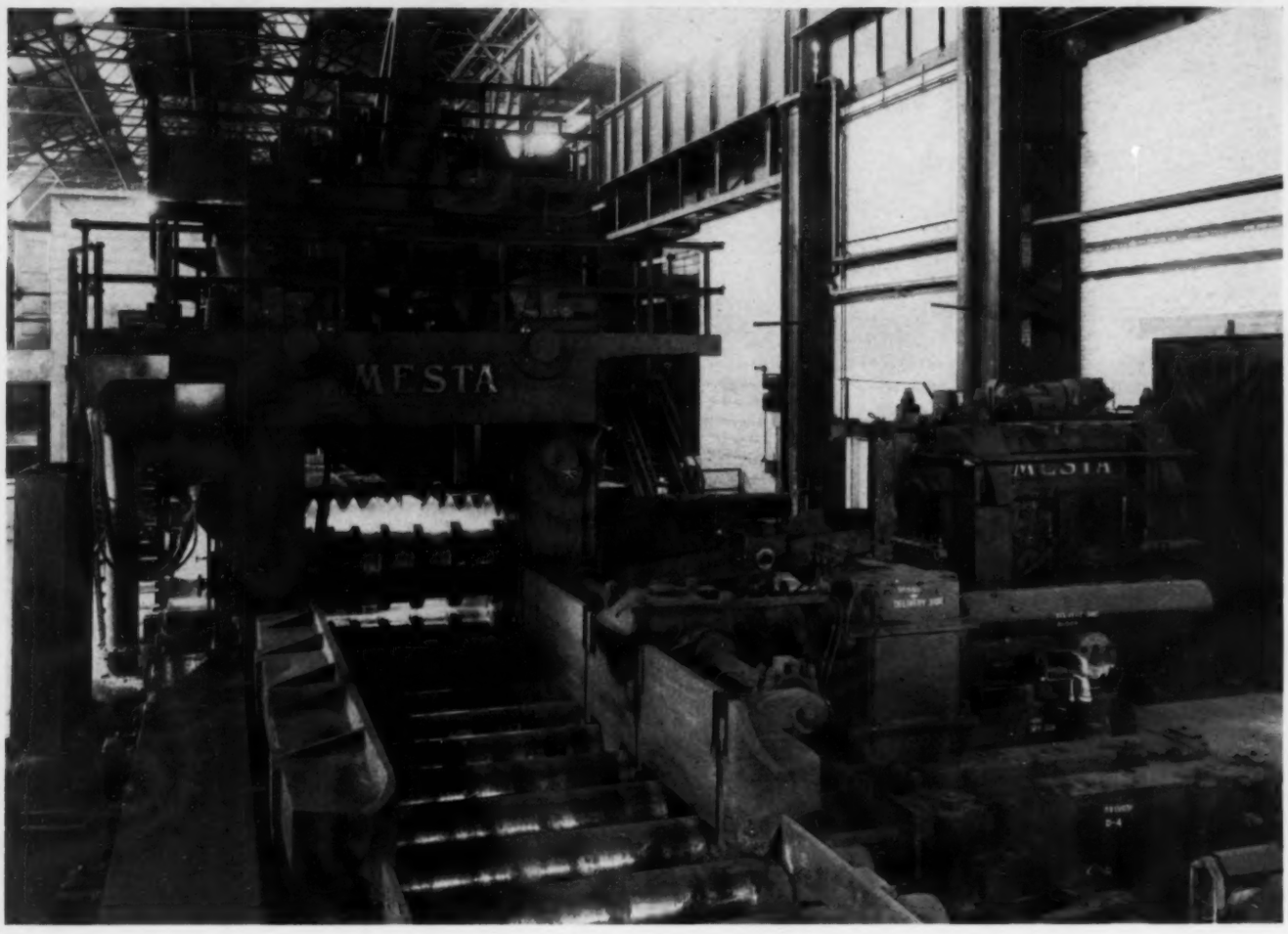
The 36 in. mill is driven by a 5000 hp, 50-120 rpm, 700 volt motor which receives its power from a motor-generator set consisting of two 2000 kw generators driven at 514 rpm by a 6000 hp, 6600 volt synchronous motor. An exciter set and a pilot exciter set complete the control of this reversing drive.

Variable voltage control is also applied to the manipulator racks, front and back mill tables and screwdown of the 36 in. mill. This control stems from a 50 kw exciter set and two motor generator sets each having two 100 kw and one 150 kw generators.

The 32 in. mill, which is located 225 ft beyond the 36 in. mill, consists of three two-high stands placed side by side: a 32 in. x 72 in. intermediate stand, a 32 in. x 68 in. leader stand, and a 32 in. x 48 in. finishing stand, spaced 14 ft 6 in. and 21 ft 3 in. apart, respectively. These housings are of cast steel, in open top design. All of these rolls have necks 20 in. in diameter running in composition bearings. The first two stands are driven by a single 5000 hp, 80-160 rpm, 700 volt reversing motor, while the finishing stand is driven by a 2500 hp, 70-140 rpm 700 volt d-c motor. Power for both of these drives comes from a motor generator set composed of three 2000 kw shunt compensated wound generators

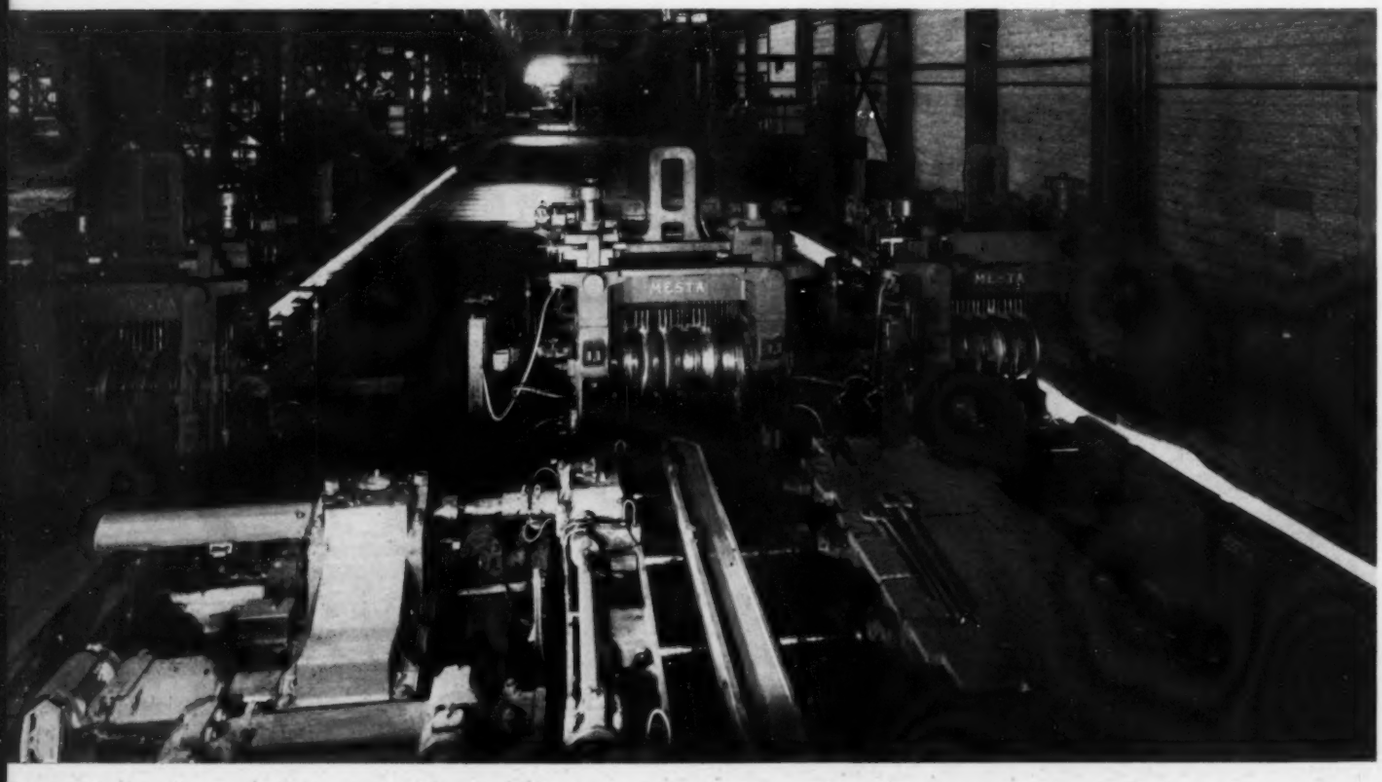
Control panel for reheating furnaces, which are equipped with automatic control of fuel-air ratio, furnace pressure, soaking zone temperature and recuperator temperature.





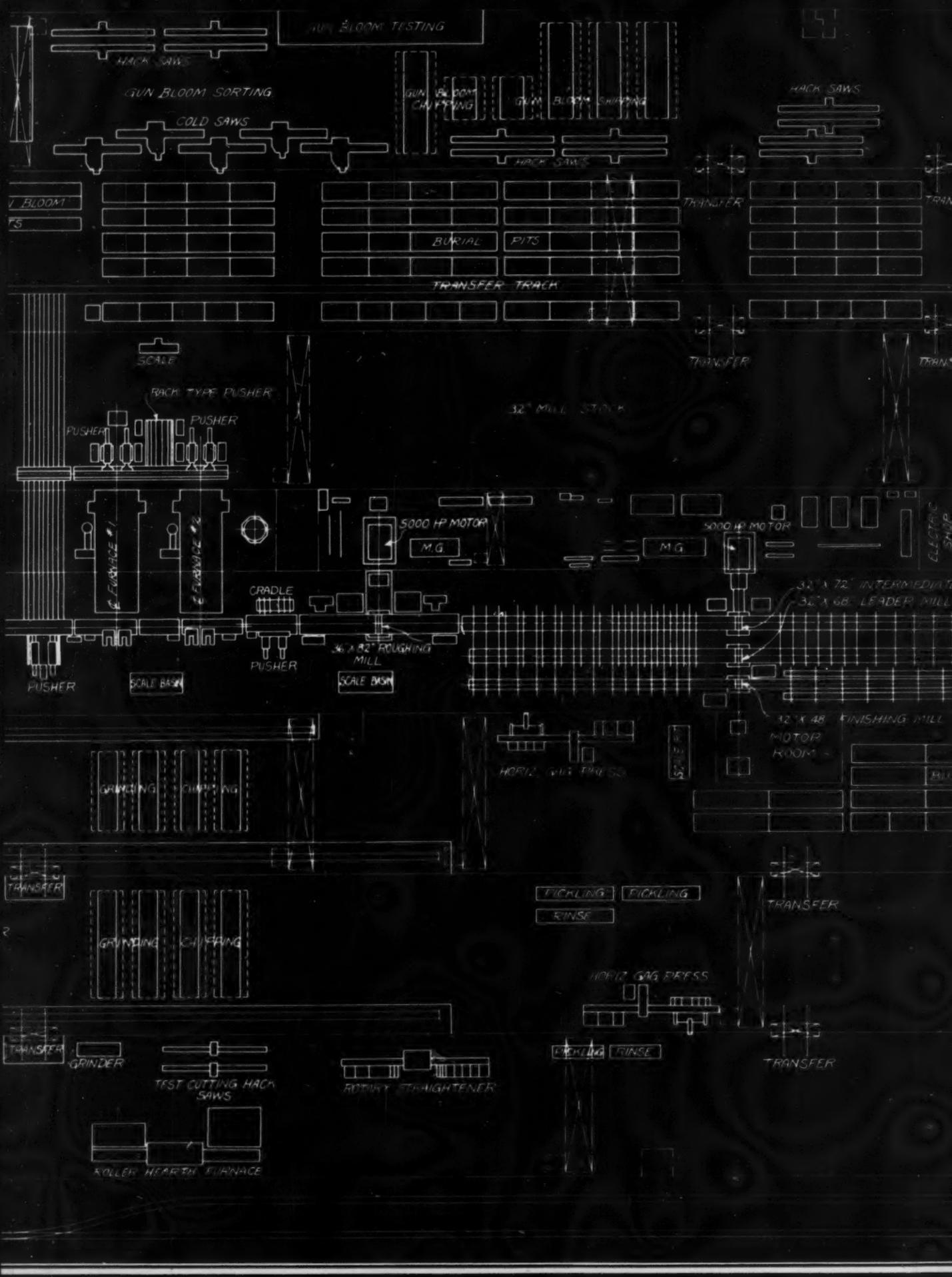
(Above) The roughing for the secondary mills is performed in a two-high 36 in. reversing stand driven by a 5000 hp motor.

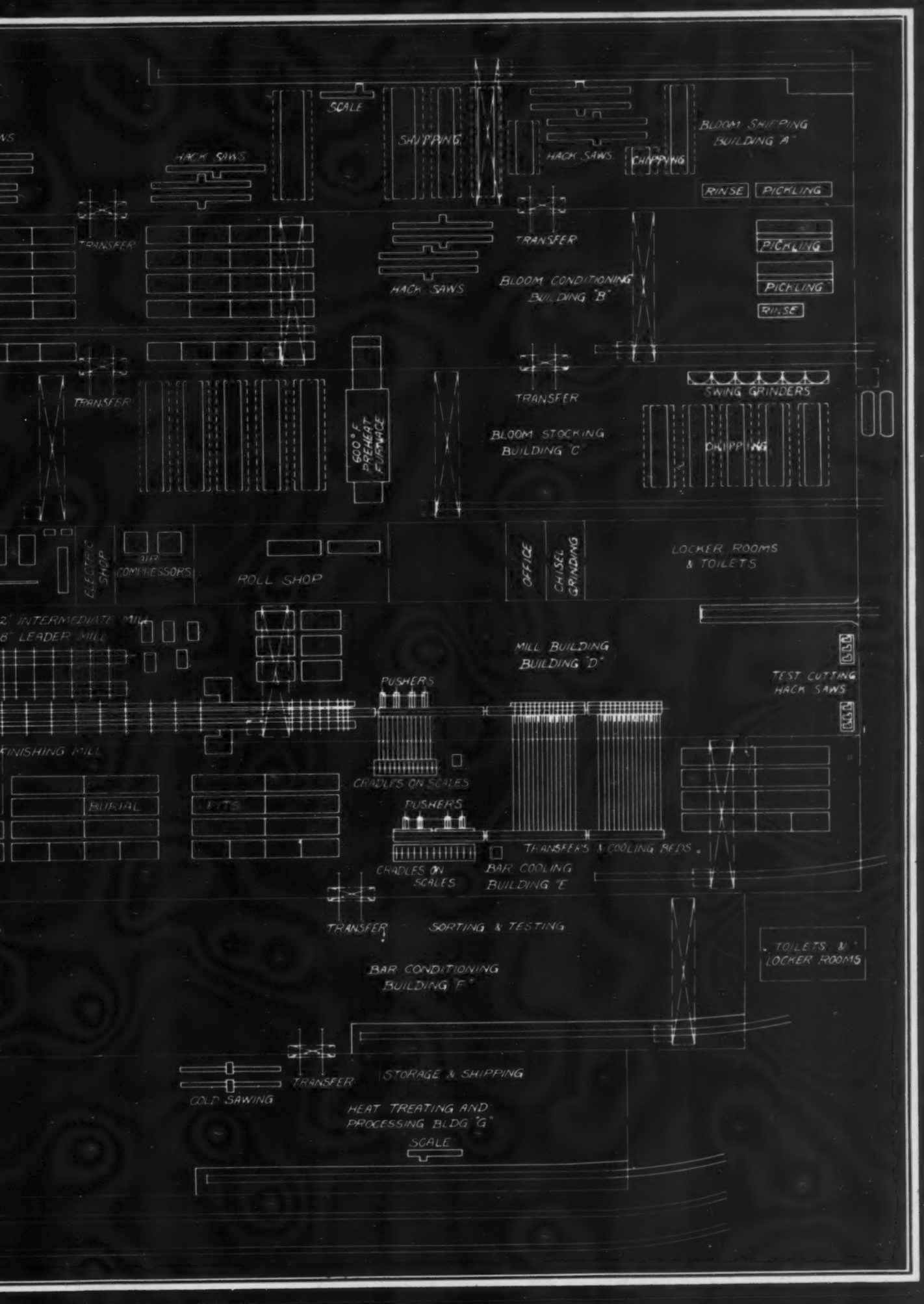
(Below) Three 32 in. stands placed side by side compose the finishing mill, which produces sizes ranging 2 3/4-7 in. squares and 3-8 in. rounds.



PLANCOR 422
SOUTH CHICAGO, ILLINOIS

Owned by Defense Plant Corporation
Operated by Republic Steel Corporation


HACK SAWS
GUN BLOOM TESTING
GUN BLOOM SORTING
COLD SAWS
GUN BLOOM CHIPPING
GUN BLOOM SHIPPING
HACK SAWS
HACK SAWS
TRANSFER
BURIAL PITS
TRANSFER TRACK
TRANSFER
SCALE
RACK TYPE PUSHER
PUSHER
PUSHER
32" MILL STOCK
5000 HP MOTOR
M.G.
5000 HP MOTOR
M.G.
CRADLE
PUSHER
36" x 82" ROUGHING MILL
PUSHER
SCALE BASIN
SCALE BASIN
32" x 72" INTERMEDIATE
32" x 68" LEADER MILL
42" x 48" FINISHING MILL
MOTOR ROOM
GRINDING
CHIPPING
HORIZ. GAG PRESS
TRANSFER
GRINDING
CHIPPING
PICKLING
PICKLING
RINSE
TRANSFER
HORIZ. GAG PRESS
TRANSFER
GRINDER
TEST CUTTING HACK SAWS
ROTARY STRAIGHTENER
PICKLING
RINSE
TRANSFER
ROLLER HEARTH FURNACE


SCALE
SAW'PING
HACK SAWS
HACK SAWS
CHIPPING
BLOOM SHIPPING BUILDING "A"
RINSE
PICKLING
TRANSFER
TRANSFER
HACK SAWS
BLOOM CONDITIONING BUILDING "B"
PICKLING
PICKLING
RINSE
TRANSFER
TRANSFER
600°F PREHEAT FURNACE
BLOOM STOCKING BUILDING "C"
SWING GRINDERS
CHIPPING
ELECTRIC SHOP
AIR COMPRESSORS
ROLL SHOP
OFFICE
CHISEL GRINDING
LOCKER ROOMS & TOILETS
2" INTERMEDIATE MILL
8" LEADER MILL
MILL BUILDING BUILDING "D"
PUSHERS
TEST CUTTING HACK SAWS
FINISHING MILL
CRADLES ON SCALES
PUSHERS
BURIAL
PITS
TRANSFERS & COOLING BEDS
CRADLES ON SCALES
BAR COOLING BUILDING "E"
TRANSFER
SORTING & TESTING
TOILETS & LOCKER ROOMS
BAR CONDITIONING BUILDING "F"
TRANSFER
STORAGE & SHIPPING
COLD SAWING
HEAT TREATING AND PROCESSING BLDG "G"
SCALE

(two for the 5000 hp motor, one for the 2500 hp motor) and an 8000 hp 514 rpm 6600 volt synchronous motor. One combination exciter set serves both drive motors while a separate pilot exciter set is provided for each drive.

All drive and control equipment for both the 36 in. and the 32 in. mills are housed in the same motor room which is ventilated by a closed, recirculating, downdraft cooling system. In the same bay are located two 1920 cfm air compressors, four roll lathes, and various maintenance departments.

On each side of the intermediate stand is an electrically operated manipulator driven by two 50 hp motors and carrying tilting fingers driven by 35 hp motors. The leader and finishing stands each has one manipulator driven by two 35 hp motors and incorporating a manually operated turning device. Rope type transfers 132 ft long connect the three lines of mill tables on the upper side of the mills, and a 108 ft transfer connects the intermediate and leader runouts on the lower side. Tables on the upper side of these stands are approximately 165 ft long, those on the down-mill side about 140 ft long.

All of the 32 in. mill stands have electrically operated screw-downs, each driven by a single 15 hp motor, but during the normal rolling process they are operated as fixed mills. Blooms from the 36 in. roughing mill are taken to the intermediate stand for three passes, transferred to the leader for one pass and on to the finisher for one pass. On larger sizes, a single pass in the intermediate stand is sufficient. The intermediate and leader stands, being coupled together with a common drive, are reversed together from pass to pass. The separately driven finishing stand operates in one direction only.

Sections coming to the 32 in. vary from 4½ in. x 5½ in. to 8¼ in. x 9¼ in. Finished sizes range from 2¾ in. squares or 3 in. rounds up to 7 in. squares or 8 in. rounds. Rounds from 3 in. to 4 11/16 in. are rolled with double radius ovals in the leader. Rounds from 4¾ in. to 8 in. are rolled in octagon-oval leader passes. Squares from 2¾ in. to 5 in. are formed in diamond passes in the leader, while for squares from 5¼ in. to 7 in. box-type passes are used in both leader and finishing stands. The mill can roll rounds up to 10 in. in diameter, although at present such provisions have not been made.

It is to be noted that the finished sizes as produced in this mill are comparatively large. The new plant includes no facilities for producing the smaller sizes, but, in the overall production picture, is complemented by the previously existing South Chicago works of Republic, where a bar mill and a combination bar and double rod mill provide rolling facilities for about 400,000 tons per year of finished bar and rod material in the smaller sizes.

The runout table from the 32 in. finisher is paralleled on each side by a table containing a 60 in. hot saw with 5 ft 6 in. stroke. This allows sawing to proceed without holding up the rolling operation. Cut lengths are then returned to a central runout which leads to a kick-off, reciprocating transfer and cradle, or to two 40 ft x 80 ft rope type cooling bed transfers. Thus, bars may be allowed to cool somewhat on the transfer or they may be rushed to burial pits direct from the mill table. Heavy duty scales with automatic recording devices up to 100,000 lb are provided at each piler cradle. Slow cooling facilities for bars consist of 22 pits 7 ft x 43 ft x 8 ft and 12 pits 7 ft x 21 ft x 8 ft, all located adjacent to the kick-off cradles.

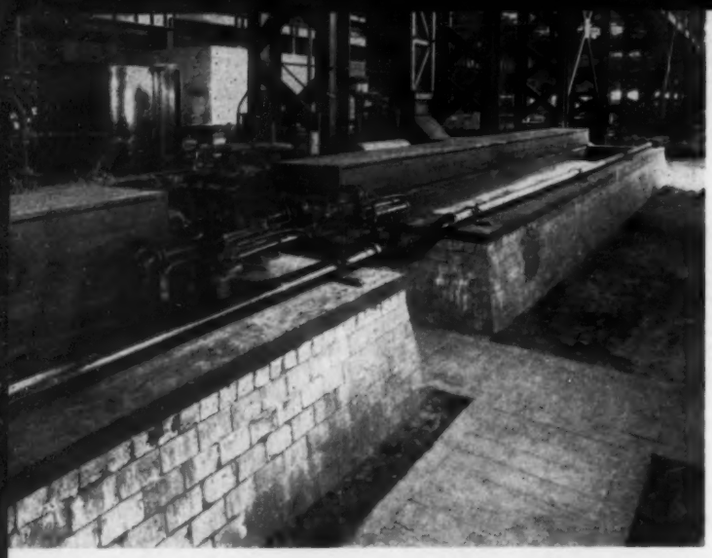
Bar finishing equipment includes one 400 ton and one 600 ton gag presses, two rotary straighteners (one capable of taking material up to 9 in. in diameter), six hack saws, three pickling tanks, two rinse tanks, and suitable grinding and chipping beds. Ten gas-fired car type annealing furnaces are installed, 9 ft 6 in. x 26 ft 6 in. in size. Three of these units are designed so that flue gases may be recirculated for low temperature (250-1250 f) operation. There is also a roller hearth heat treating furnace.

Another view of the first two stands of the 32 in. mill which are operated together as a reversing unit from a single 5000 hp motor.

As may be noted from the accompanying layout, all rolling and finishing operations proceed in what is essentially a single building 8 bays wide, of high and low bay construction. The mill building proper, which is 90 ft wide x 1400 ft long is approximately in the center. To the left of the mill building are a 50 ft shop and motor room bay, a 100 ft bay for conditioning and stocking material for rerolling, a 100 ft bay containing slow cooling burial pits, and a 100 ft bay for preparation and shipping of gun blooms. To the right of the mill bay are two 100 ft bays and one 90 ft bay, all devoted to the finishing, heat treating and shipping of the rerolled bars. These bays vary from 1250 ft to 1350 ft in length, varying principally because of the irregular shape of the plant site. Thus, under the 22 acres of roof, each product follows its own separate way through the various processes in a smooth, continuous flow line.

Cranes installed in the mill building are as follows:

Gun bloom building	One 20 ton, two 15 ton
Burial pit building	Four 15 ton
Bloom stock building	One 20 ton, three 15 ton
Shop bay	Two 50 ton
Mill building	One 25 ton, one 125 ton
Bar cooling building	Four 15 ton



Pickling tanks are of brick construction and are heated by submerged combustion burners.

Bar conditioning building.....Three 15 ton
Heat treating and processing.....Two 15 ton

Cross-bay transfers are provided at all points where the material passes from one building bay to the other.

SERVICE DEPARTMENTS

The extremely stringent quality requirements for steels for aircraft and gun tube use naturally result in an unusual amount of metallurgical testing. Hence, a metallurgical laboratory was installed which provides equipment for handling as much as 100 tons of tests per day, with complete facilities for routine physical testing, macro-etching, microscopic examination, magnetic powder-testing, hardenability determination, etc., as well as for special research work. Previous mention has been made of special chutes at the blooming mill shear and hot saws for handling test pieces. At these points small furnaces have been installed for slow-cooling the test pieces when necessary.

Electric power for the entire plant is purchased from the utility company serving the district at 66,000 volts. Incoming power goes through the main substation where three 3-phase 40,000 kva transformers reduce the voltage to 12,000 and 6600 volts. The 12,000 volt power goes directly to the arc furnace transformers, while 6600 volt power is distributed around the plant. Where the character of the load dictated, the 6600 volt power is further reduced to 2300 volts serving an immediate area.

Location	*Transformers*
Blast furnace power house	
	(2) 3000 kva, 6900/2300, 3 phase
	(2) 1200 kva, 6900/460, 3 phase
Open hearth stockhouse	
	(2) 2000 kva, 6900/460, 3 phase
Rolling mill building	
	(2) 2500 kva, 6900/2300, 3 phase
	(5) 1200 kva, 6900/460, 3 phase
Pump house	
	(2) 1500 kva, 6900/2300, 3 phase
	(3) 37.5 kva, 2300/208/120, 3 phase
Coke plant	(2) 1000 kva, 2300/460, 3 phase
Machine shop	
	(1) 1200 kva, 2300/460, 3 phase
Sinter plant	
	(3) 150 kva, 2300/460/230, 1 phase
Metallurgical building	
	(1) 750 kva, 2300/230, 3 phase
	(1) 750 kva, 2300/460, 3 phase
	(3) 100 kva, 2300/230/115, 1 phase

In order to keep the power demand from reaching excessive values, a demand control system was installed.

Ten gas-fired car type annealing furnaces are installed, three of which are designed for recirculation of flue gases for low temperature operation.

This shop in the metallurgical laboratory has all the aspects of a production shop and is in fact laid out to handle as much as 100 tons of test pieces per day.

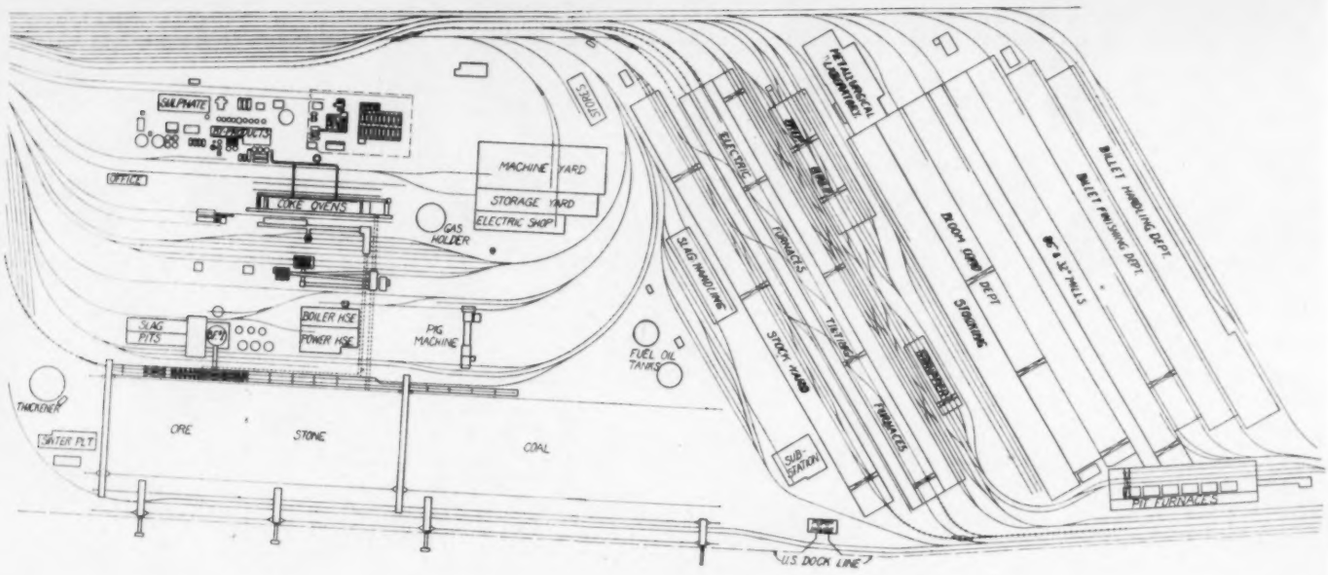
As previously indicated, the plant power supply consists of two main divisions — 12,000 volts for electric furnace operation and 6600 volts for main drives and auxiliaries. In the main substation, duplex control panels for switching are arranged in an open sided rectangle with the operator's desk in the center.

Each circuit leaving the main substation (nine 12,000 volt circuits at the left of the operator and nine 6600 volt circuits at the right of the operator) is equipped with indicating and graphic instruments. On the rear of the duplex panels are located the necessary relays and integrating kwhr meters with graphic demand attachments for each circuit.

The main totalizing and demand control panel is located directly in front of the operator. All of the 12,000 volt furnace power is totalized on a single indicating demand meter and a recording kw/kva demand meter. Similar equipment is provided for the 6600 volt power. By means of a totalizing relay the total power demand is measured on a similar indicating demand meter. This panel is also equipped with a print type total demand meter which is paralleled with the power company print type instrument by means of relays so that duplicate demand records are established. This makes the billing demand record available to the operator at all times.

The indicating demand meters are the conventional type equipped with predetermined demand setting which operates suitable alarms and lights when the

Unit substations of the type shown here are located at various load centers around the plant. This one is placed overhead between two bays of a building.



General layout of Plancor 422, a complete plant for the production of high quality steels from the basic raw materials, owned by Defense Plant Corporation and operated by Republic Steel Corporation.

demand is exceeded at any time during the ½ hour demand period.

When it is desired to control loads the operator may signal the offending substation either by telephone or electric signaling devices located at these remote substations.

D-c power for auxiliary equipment throughout the plant is provided by nine duplicate 1500 kw motor generator sets, three located at the blast furnace powerhouse, two at the open hearth substation, one at the 44 in. mill, and three at the 36 in. and 32 in. mills.

Plant fuel is, for the greater part, a by-product of the plant itself. Blast furnace gas (about 6,000,000 cu ft per hr) is distributed approximately 26 per cent to blast furnace stoves, 25 per cent to the coke ovens and the balance to the blast furnace boilerhouse. Coke oven gas (approximately 700,000 cu ft per hr) goes to a mixing station where an interconnection of natural gas is provided so arranged that any deficiency of coke gas is made up by a mixture of natural gas or air. Thus, gas controlled to a calorific value of 500-550 Btu per cu ft is piped to all furnaces in the plant.

Fuel oil may also be used on the tilting open hearth furnaces. Two 500,000 gallon fuel oil storage tanks are constructed of reinforced concrete. As many as 10 tank cars of oil can be simultaneously unloaded into a receiving reservoir 4 ft 6 in. wide x 360 ft long x 7 ft 8 in. deep, from where it is moved into the storage tanks by two 400 gpm, 50 ft head transfer pumps. Two 60 gpm, 350 psi pumps circulate oil through the fuel oil system in the open hearth.

Steam for all plant usage comes from two sources. At the blast furnace plant there are three boilers, each of 75,000 lb per hr capacity at 300 psi pressure and 650 F temperature. These boilers are fired with blast furnace gas with powdered coal as an emergency standby. At the open hearth are four fire-tube waste heat boilers, each with a capacity of 20,000 lb per hr at 300 psi pressure and 650 F temperature. Steam is consumed by the blast furnace turbo-blowers, in some mill process work, for heating and atomizing fuel oil in the open hearth and for general plant heating. At several points around the plant, steam pressure is reduced to 150 psi, 50 psi, or 20 psi, as required for the particular purpose.

Service water for the entire plant is drawn from the adjacent river by four pumps, two of 17,500 gpm and two of 20,000 gpm capacity. Water for boiler feed purposes is treated in a continuous hot process softening plant.

Two large maintenance shops provide complete repair facilities for the new plant. In the mechanical building, which is 402 ft x 142 ft, there are shops for machine, pipe, rigger, forge, carpenter, boiler and welding work. The electrical shop is 282 ft long x 61 ft wide.

Acetylene and oxygen are piped to the large, permanent consuming departments through distribution systems fed from central supply stations.

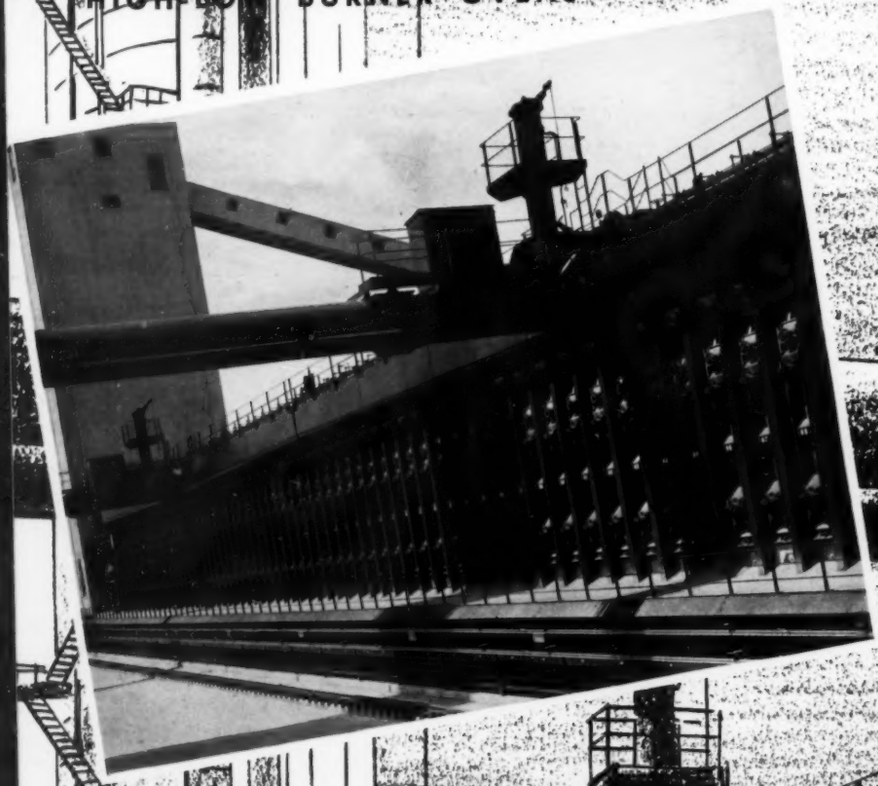
Four 65 ton diesel locomotives handle the open hearth and electric furnace work and three 100 ton diesel-electric handle interplant transportation. There is also a 40 ton diesel locomotive crane. Approximately 30 miles of standard gauge tracks are installed in the plant.

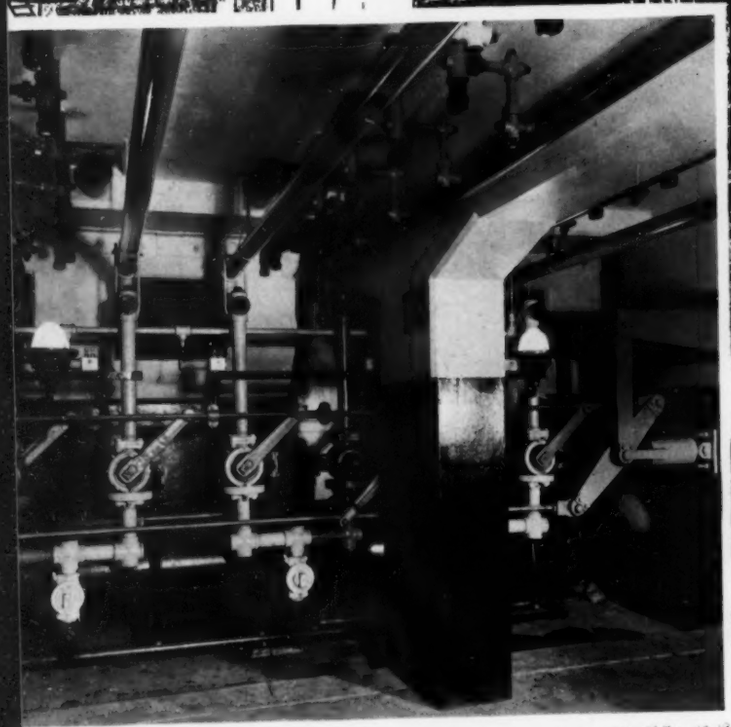
One of the interesting points of the new plant is the degree to which steel was eliminated from the construction. Concrete was substituted to an unusual degree, almost 465,000 cu yd being used. Reinforced concrete was used for all high-line supports, for large fuel oil storage tanks, for mixing and storage bins at the coke plant and blast furnace, for mill pulpits, and for some large water pipes, as well as for the boiler house, shop buildings and sintering plant. Much flat and corrugated cement asbestos material was used for siding and roofing of mill buildings, as well as some precast concrete roof deck with composition roofing.

75 WILPUTTE UNDERJET HIGH-LOW BURNER OVENS

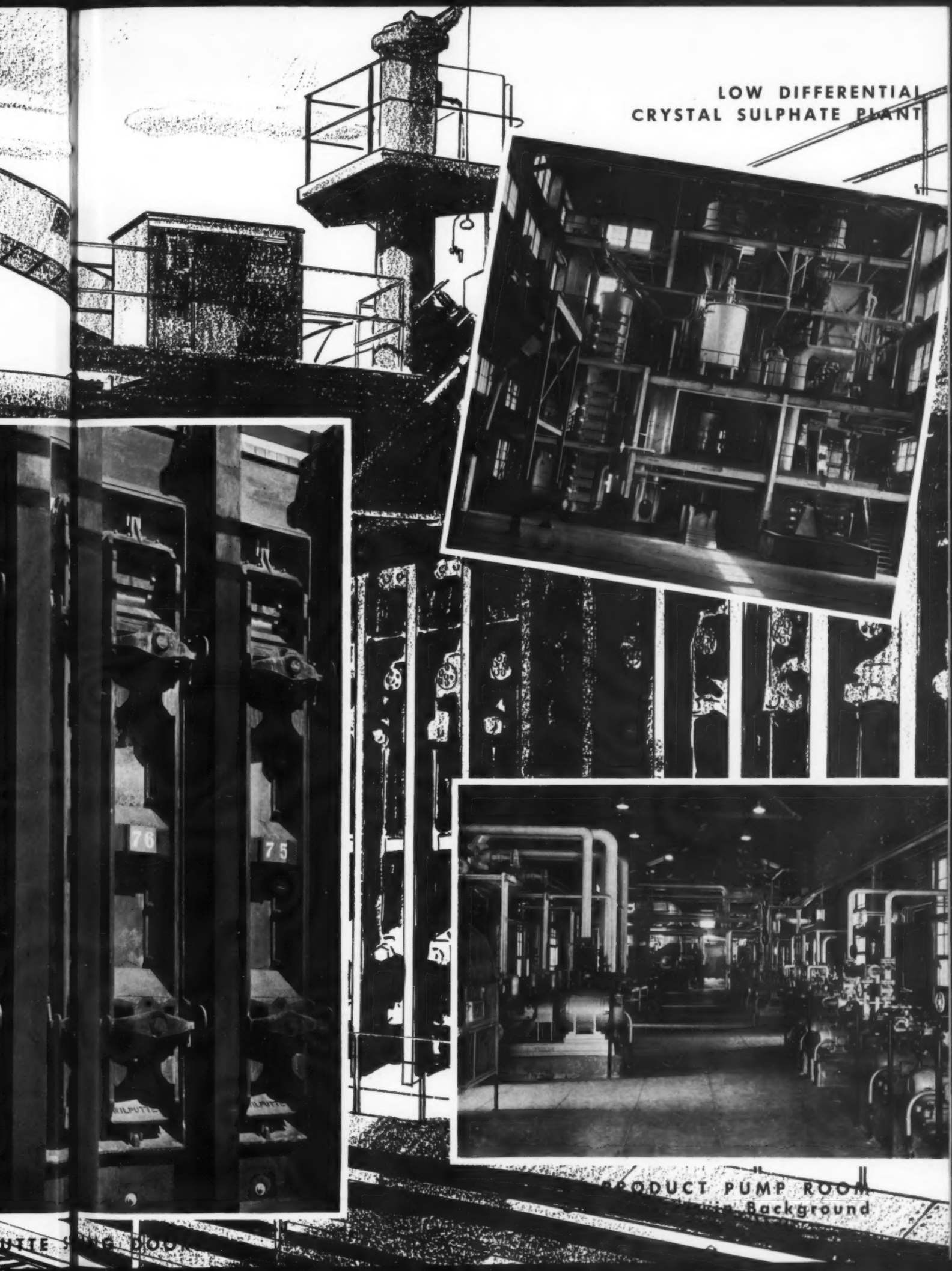
WILPUTTE COKE OVEN CORPORATION

BATTERY OF WILPUTTE UNDERJET
HIGH FLOW BURNER OVENS





FUEL GAS MANIFOLDS
basement under ovens


LOW DIFFERENTIAL
CRYSTAL SULPHATE PLANT
76
75
PRODUCT PUMP ROOM
in Background

BY-PRODUCT RECOVERY PLANT

WILPUTTE COKE OVEN CORPORATION

A SUBSIDIARY OF SEMET-SOLVAY COMPANY

40 RECTOR STREET NEW YORK 6, N. Y.

TIMKEN BEARINGS

Have Starring Roles in New Electric Furnace Steel Plant . . .

A great many Timken Tapered Roller Bearings are used in the equipment of this up-to-the-minute Chicago district plant.

Four of the most important Timken Bearing applications are shown in the photographs reproduced here. They are, top to bottom, (1) No. 4 Medart Straightener. (2) Continental Manipulator Drive for blooming mill. (3) Blooming Mill stand and table. (4) Brosius Clay Gun.

The Medart Straightener uses Timken Bearings on the pinion shaft, first and second intermediate shafts, roll drive shaft, inclined roll shaft, and coupling.

In the Continental Manipulator Drive, Timken Bearings are used on the rack pinion shaft, drive pinion shaft, pusher wheels, puller wheels, and hold-down wheels.

The Blooming Mill is equipped with Timken Bearings in the screwdown mechanism and on the table rolls.

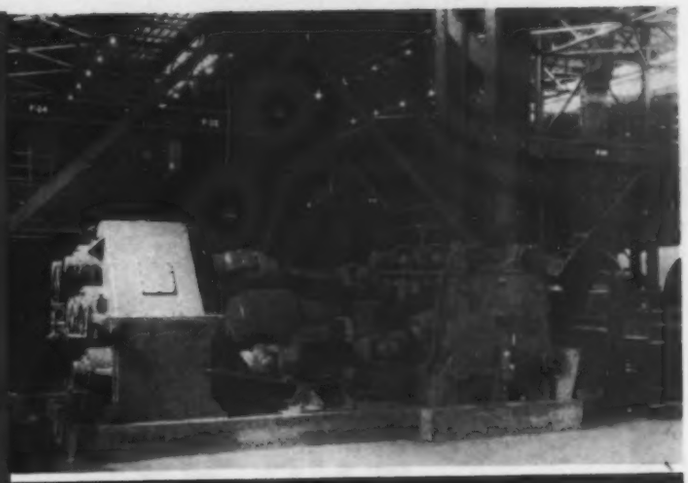
Timken Bearings are applied throughout the drive of the Brosius Clay Gun.

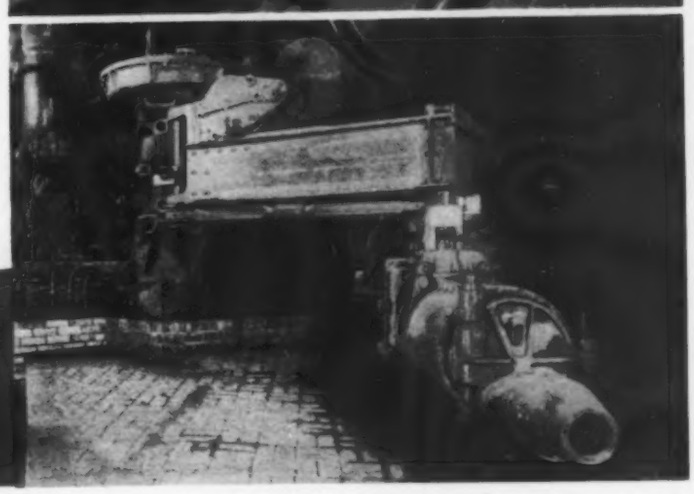
In addition to these outstanding applications, Timken Bearings are used in various other types of equipment including roll lathes, hot saws, cranes, soaking pit cover mechanism and charging machines.

More Timken Bearings — including roll neck bearings — are used in American steel mills than any other anti-friction bearings. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

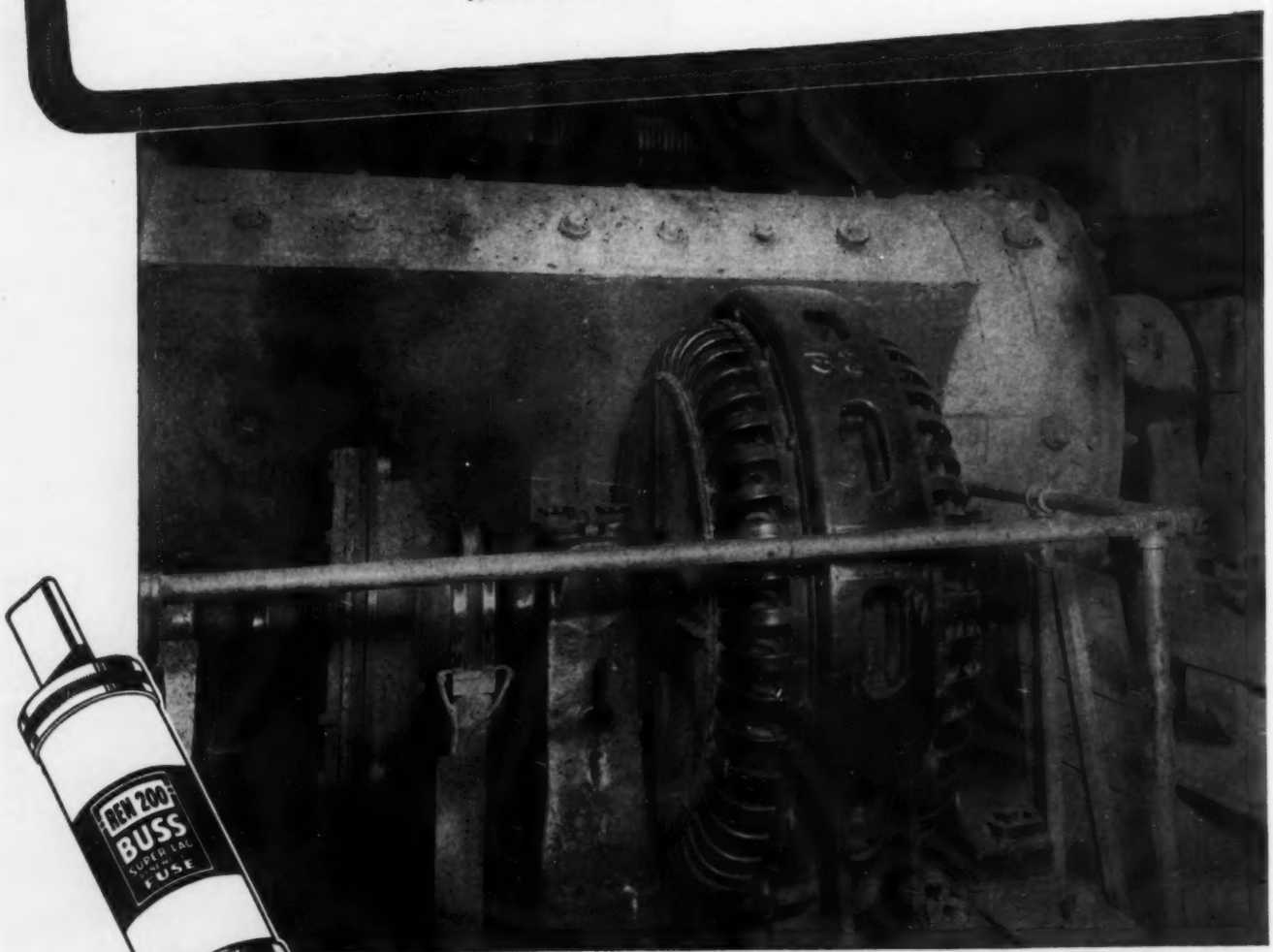
TAPERED ROLLER BEARINGS





"We Reduced Fuse Maintenance and Eliminated Costly Shutdowns —on our Tube Mill with BUSS Super-Lag Fuses"

Reports Mr. H. W. Smith, Vice Pres. in charge of Operations
Riverton Lime & Stone Co., Riverton, Virginia



BUSS SUPER-LAG

SOLD THROUGH WHOLESALERS

Mr. Smith explains—"Several years ago costly shutdowns on our tube mill were occurring much too frequently due to fuses blowing. A salesman suggested that BUSS Super-Lag fuses might correct the trouble. After installing them we stopped having needless fuse blows. We credit the long time-lag of BUSS fuses with preventing these interruptions of our production as well as with greatly reducing our fuse maintenance costs."

TIME AFTER TIME in plant after plant, the use of BUSS Super-Lag fuses has reduced fuse maintenance, saved production time, saved money, and kept production up. You, too, can get the same result by using BUSS Super-Lag fuses. The experience of the Riverton Lime and Stone Company is one of a long list of successful installations that proves that fuse blowing on harmless overloads can be reduced by using BUSS Super-Lag Fuses.

BUSS fuses require no maintenance or periodic inspection. They don't open needlessly. If one opens, you can be sure some condition needs correction. When one opens, it requires less than 45 seconds to renew with an inexpensive link.

Here is why BUSS fuses greatly reduce or entirely prevent needless blows

The fuse case is designed to insure good contact on the link, even when the fuse is renewed by an inexperienced person—and it is so designed that vibration or heavy overloads or the constant heating and cooling of the fuse will not permit poor contact to develop. Thus excessive heating which causes fuses to blow needlessly is prevented.

The fuse link used is the famous "BUSS Super-Lag." It has lag-plates attached to it. These give it a time-lag so long that it will reduce to an extent not possible with any other renewable fuse, the number of Shutdowns caused by needless fuse blows.

How to solve the "shutdown problem"

Pass the word along that all purchase records dealing with circuit protective devices should be immediately changed to call for BUSS Super-Lag Renewable fuses. Then, as fuses are replaced or new installations made, your plant will automatically get the benefit of the carefree, trouble-proof protection that BUSS Super-Lag fuses afford. BUSSMANN MANUFACTURING CO., University at Jefferson, St. Louis, Missouri. *Division McGraw Electric Company.*

FUSES

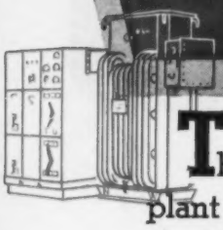
Why BUSS Fuses Don't Blow Needlessly

10 FEATURES in the design of the FUSE-CASE help make it possible.

and

The **SUPER-LAG** development in the FUSE-LINK completes the job.

Wagner
Unit Substations
ASSURE CONTINUITY OF SERVICE IN THIS MODERN STEEL PLANT...



These Wagner unit substations, installed in a new, modern, integrated steel plant located in the Chicago district, are typical of how Wagner is serving the steel industry.

Equipment of this type is built for either indoor or outdoor service. *Unit substations intended for indoor installation have transformers filled with a non-inflammable liquid.

Wagner unit substations, consisting of transformers coupled to switchgear having any desired combination of circuit breakers, meters, etc., can be supplied to meet any load requirement.

ADVANTAGES:

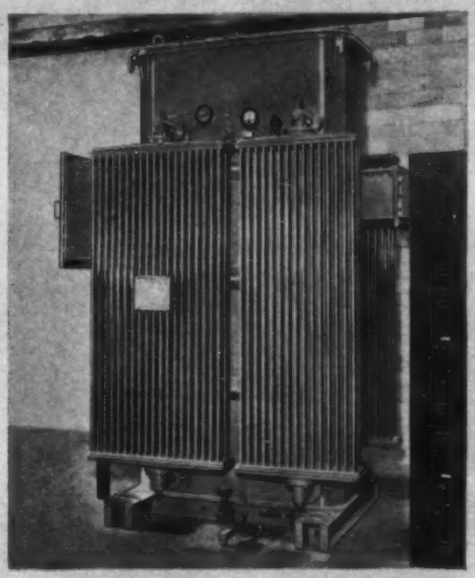
TRANSFORMERS
are but one of several WAGNER PRODUCTS serving industry.

Other WAGNER PRODUCTS:
AIR BRAKES
BRAKE LINING
HYDRAULIC BRAKES
INDUSTRIAL BRAKES
INDUSTRIAL BRAKE CONTROLS
TACHOGRAPH (Recording Speedometer)
ELECTRIC MOTORS

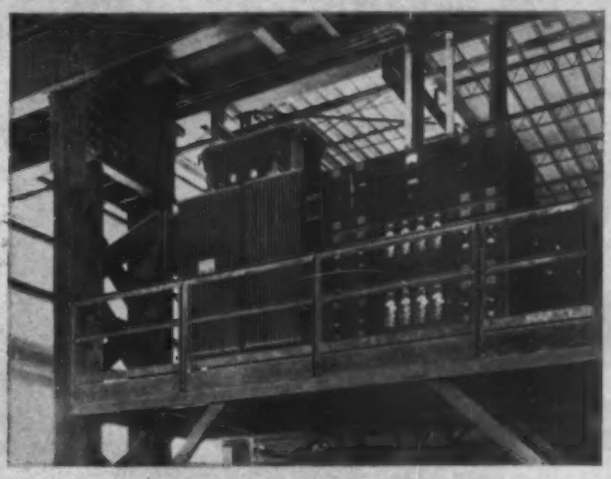
- Simplifies installation. Complete substation is shipped in one or more factory-assembled units, completely wired, ready for installation and final connection.
- Improves performance of motors and lights. Inherent linedrop is avoided by eliminating long low-voltage feeders.
- Saving of copper in connecting cables. Locating the transformer near the load allows the use of shorter and smaller cables over a great part of the distance the power must travel.
- Low maintenance expense. The complete enclosing of the buses and other equipment practically eliminates cleaning and dust problems and assures safety against contact with line parts.
- Provides flexibility to meet future conditions.
- *Can be installed indoors without the use of expensive fireproof vaults.

T44-17

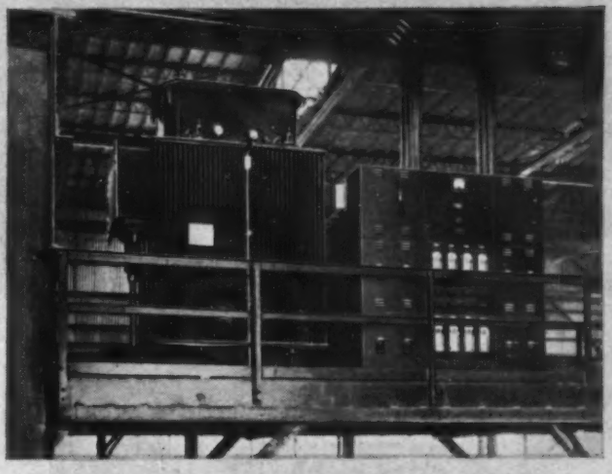
Wagner Electric Corporation
ESTABLISHED 1891



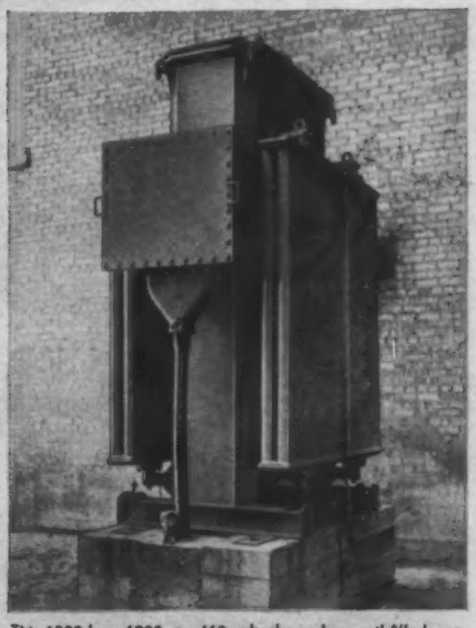
A Wagner 1200-kva, 6900- to 460-volt, three-phase unit substation consisting of a Noflamol transformer equipped with an air-filled primary junction box, and low-voltage switchgear having eight feeder circuit-breakers rated at 25,000-ampere interrupting capacity, eight watt-hour meters, one voltmeter, and one 50,000-ampere main-circuit breaker.



Another 1200-kva Wagner unit substation installed on a balcony.



Wagner unit substation with same rating and switchgear equipment as the one illustrated above, installed on a balcony out of the way.



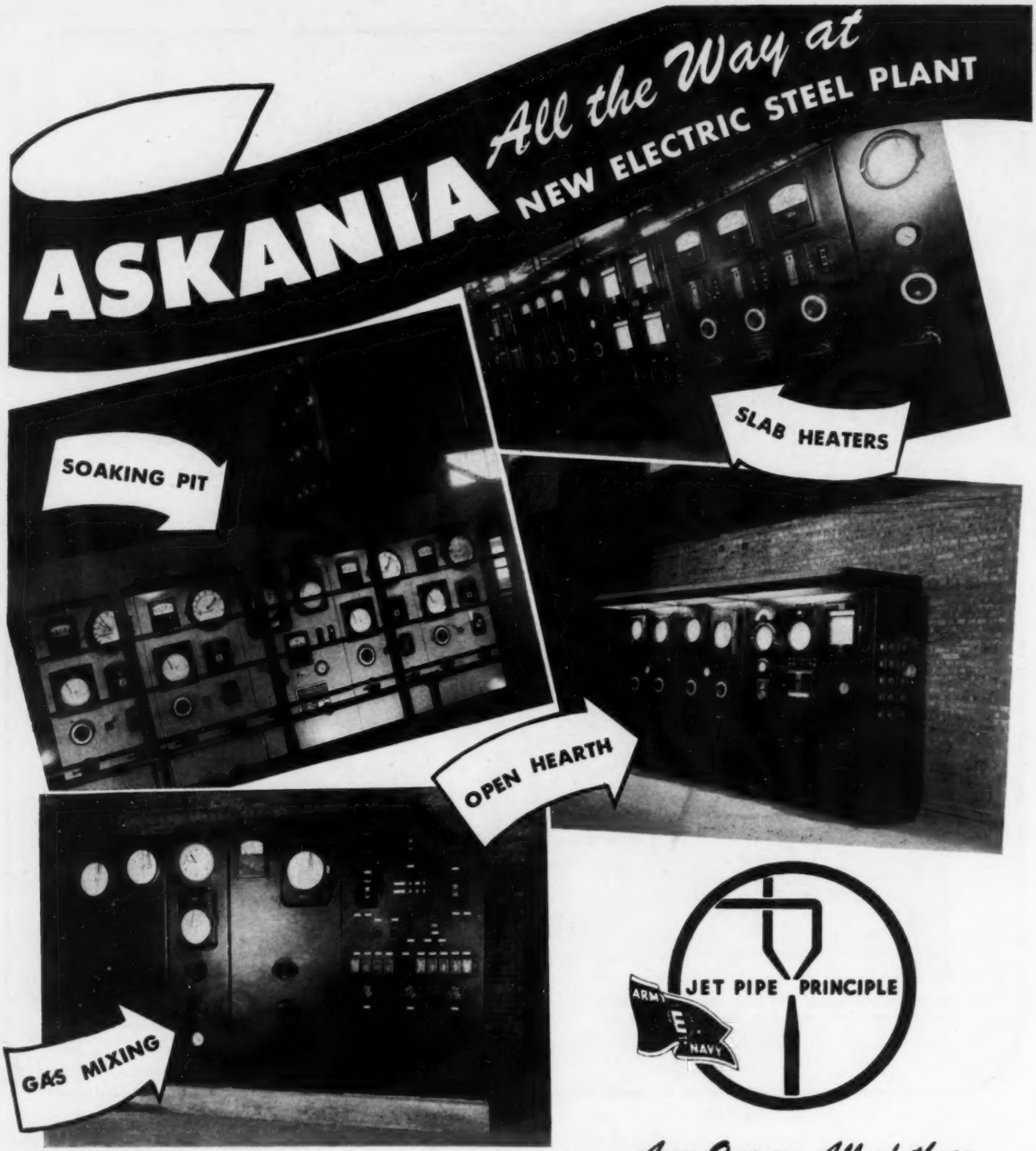
This 1200-kva, 6900- to 460-volt, three-phase, oil-filled, outdoor, weatherproof transformer is equipped with a primary junction-box with pothead. The secondary bushings come through the transformer tank wall into a throat that connects to bus duct through building wall from the switchgear assembly.

Write for Descriptive Data

Data sheets on Wagner unit substations are available and will be mailed on request. Wagner's trained field engineers will gladly help you in the selection of the right unit substations to meet your requirements.

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

ASKANIA *All the Way at* NEW ELECTRIC STEEL PLANT



IN this newest Steel Plant every step in the steel making process is guided by Askania Automatic Control . . . 4 Open Hearth Furnaces . . . 24 Soaking Pits . . . Gas Mixing Station . . . 2 Blast Furnace Blowers . . . 3 Hot Blast Stove Burners . . . 2 Three-Zone Slab Heating Furnaces . . . 14 Heat Treating Furnaces . . . 2 Gas Boosters . . . 2 Gas Exhausters . . . 2 Collecting Main Regulators . . . 1 Stack Draft Regulator . . . 1 Oven Fuel Gas Regulator.

A TOTAL OF 116 REGULATORS

JET PIPE PRINCIPLE

ARM E NAVY

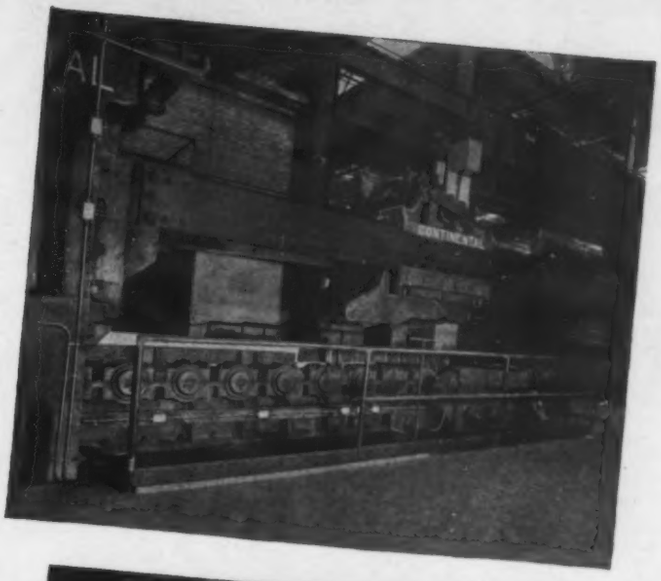
Any One or All of these Bulletins

YOURS FOR THE ASKING

- No. 100—PRESSURE CONTROL
- No. 101—RATIO CONTROL
- No. 115—OPEN HEARTH
- No. 116—SOAKING PIT

ASKANIA REGULATOR CO.

1603 S. MICHIGAN AVENUE, CHICAGO 16, ILL.



Trabon
STEEL MILL LUBRICATION

SERVICE-PROVED for years on roll stands, run-out tables, overhead traveling cranes, revolving blast furnace tops, ore bridges, shears and other steel mill equipment of all kinds, Trabon assures ***efficient, trouble-free*** operation.

Trabon lubrication makes absolutely certain that every bearing receives just the desired amount of lubricant ***while the mill is in operation.*** It prolongs bearing life,—avoids breakdowns, and production tie-ups,—minimizes accidents and compensation costs.

Trabon means automatic—centralized—positive—and proven lubrication. It requires a single line of piping only, minimizing installation time and costs,—uses fully enclosed feeders that can be placed in the most advantageous position available even though they are hidden from view,—and offers many other advantages. A newly completed bulletin gives full details. Send for a copy.

TRABON
ENGINEERING CORPORATION

1825 East 40th Street, Cleveland 3, Ohio • Industrial Lubrication Exclusively Since 1922

ORIGINATORS AND PATENT OWNERS OF THE
SINGLE LINE REVERSING LUBRICATING SYSTEM

"3C" STEEL MILL CONTRO

The solution of Electrical Control problems in this huge new Steel Mill are typical examples of "3C" Applicationeering, that is, applying the known characteristics of "3C" apparatus to definite electrical control problems—requiring thorough knowledge of the apparatus and a wide experience gained in solving similar problems.

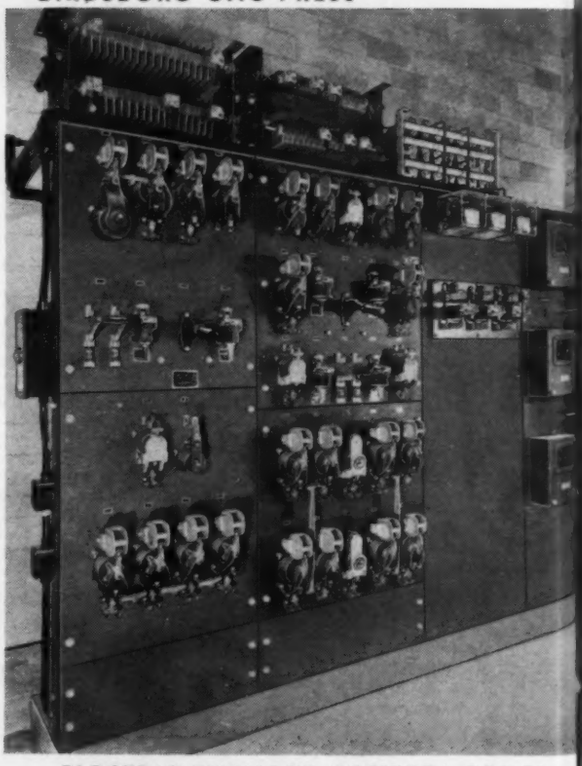
"3C" Applicationeering service is as handy as your telephone.

GAG PRESS
CONTROL PANEL

"3C" MASTER SWITCHES

BIRDSBORO GAG PRESS

RIGHT AND ABOVE:—400 Ton Gag Press and associated control equipment, consisting of seven panels of "3C" Bulletin 9300 series, heavy duty, steel mill, auxiliary controllers. This Gag Press makes thirty-three strokes per minute, each stroke exerting a pressure of eight hundred thousand pounds on the round bar or square billet being straightened, and will handle bar sizes ranging from three inches to six inches. A similar installation controls a 600 Ton Gag Press handling a range of bar sizes from five inches to nine inches. "3C" Bulletin 101, heavy duty, mill type Master Switches are mounted on the Operator's platform at the far end of the machine.



ELECTRIC FURNACE CONTROL PANEL

RIGHT:—One set of nine electric furnace controllers, for control of the tilting motion and electrically operated doors. The left hand panel is a special "3C" Bulletin 9320, 35 hp., 230 volt, direct current, reversing, dynamic braking, heavy duty, steel mill auxiliary controller operating the tilting motion. The panel immediately adjacent to it is a special "3C" Bulletin 9315, reversing, plugging controller operating two 6¼ hp., series wound door motors. Note the dead front, main line disconnect switch and "3C" Bulletin 111, cast grid resistors mounted above the panel. All motions are operated through "3C" Bulletin 101, heavy duty, mill type Master Switches with a special "3C" Bulletin 101 Foot Switch for the tilt motion to give dead man protection.

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

N THE CHICAGO AREA

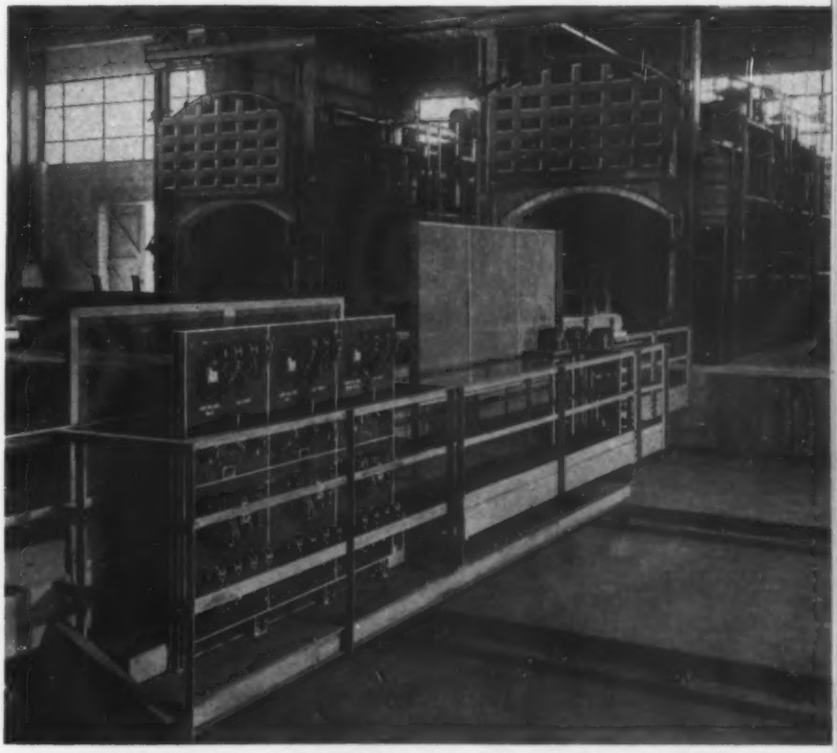
ROLLER HEARTH FURNACE

ABOVE:— Rear view of large Roller Hearth Furnace with associated "3C" auxiliary drive control panels. The left hand panel is a special Bulletin 9320, 50 hp., 230 volt, direct current, reversing, dynamic braking, steel mill auxiliary controller and adjacent to it are two special Bulletin 9315, 25 hp., 230 volt, direct current, reversing, plugging, heavy duty, steel mill controllers. The fourth panel is a special 440 volt, 3 phase, 60 cycle, multi-motor panel, providing Across-the-line type starting for a total of eight a.c. auxiliary drives. "3C" Bulletin 110, unbreakable, non-corrosive, Edgewound Resistors are mounted above and to the rear of the direct current panels. The bars and billets are delivered to the interior of the furnace on alloy rolls and are oscillated during the heating period to provide uniform temperatures throughout. After processing in this manner, the material moves to the delivery table which is equipped with a hoisting mechanism dropping the bars or billets into a quench tank, filled with oil or water as required.

BELOW:—"3C" Bulletin 9320, 150 hp., 230 volt, direct current, reversing, dynamic braking, heavy duty, steel mill auxiliary controller for a large, two roll rotary straightener. "3C" Bulletin 110, unbreakable, non-corrosive, edgewound resistors are mounted on platform above control panel. This machine straightens round alloy bars up to a maximum size of four inches in diameter at speeds of from 30 to 120 feet per minute, this adjustable feed being obtained through "3C" Bulletin 125, heavy duty, mill type Field Rheostat.

MEDART STRAIGHTENER

RIGHT:—Portion of a special transfer car serving a total of ten Annealing Furnaces. It is operated by the three duplicate controllers illustrated, each being a "3C" Bulletin 9325, reversing, plugging, dynamic braking, heavy duty steel mill auxiliary controller. The transfer car is provided with a double track arrangement and two car pullers. A completely annealed charge is drawn from the furnace onto one track by one car puller and the Operator moves the transfer car to line up the second track which has a new load on it ready for charging. The second car puller then loads the new charge into the annealing furnace. Thus very little time is lost between the removal of a completely processed charge and the introduction of a new batch of material to be annealed.



"3C" CONTROL FOR ANNEALING FURNACE TRANSFER CAR

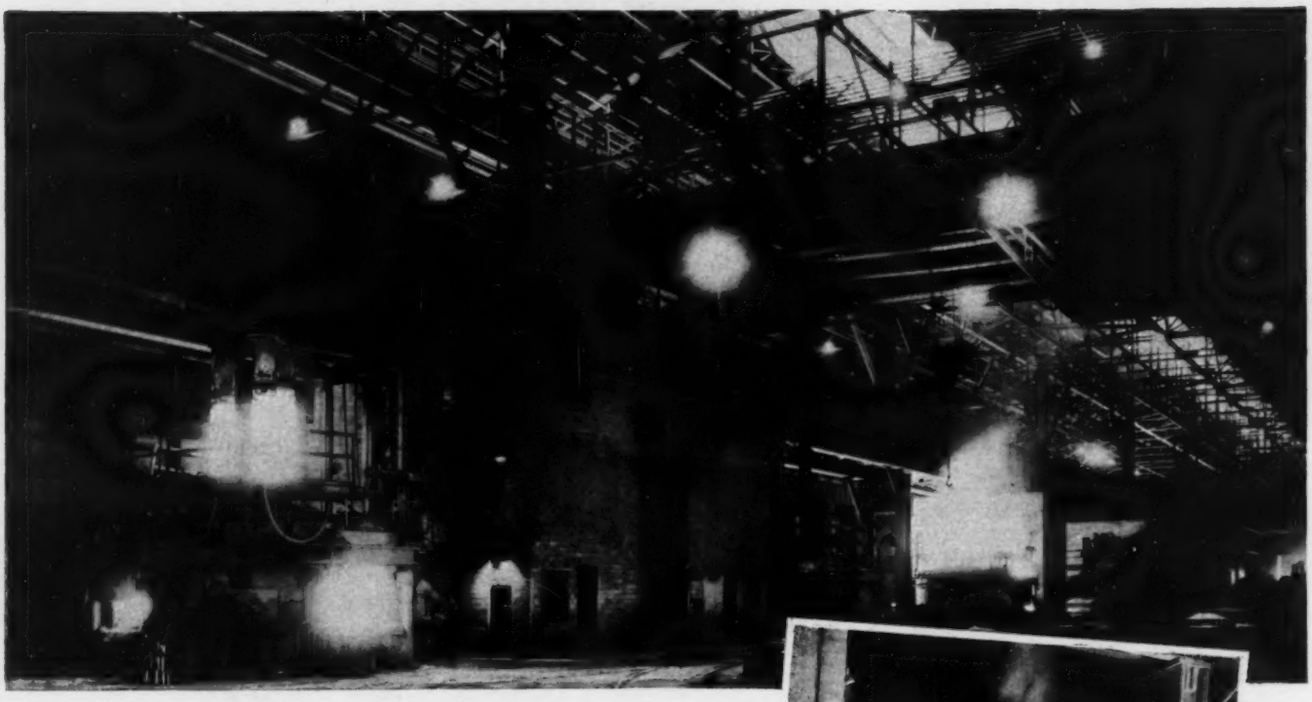
CONTINUE TO ROLL WITH CLARK CONTROL

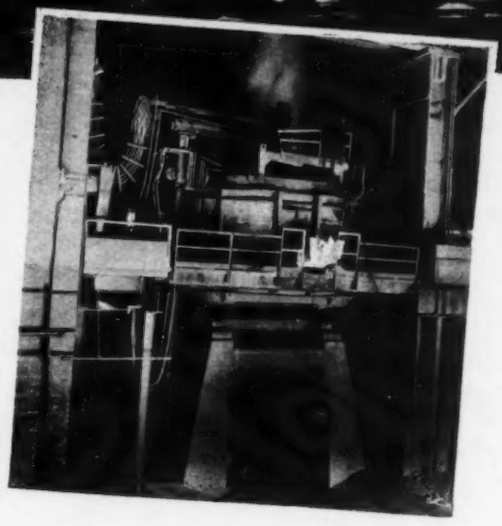
THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO

NINE *Heroult* FURNACES

equip the world's largest electric steel plant





NOW producing high-alloy steel in the Chicago district, this battery of nine Heroult Electric Melting Furnaces (Type-70 units) were built and recently installed by the American Bridge Company.

Features that make them the last word in modern electric furnace design, include:

1. All-welded design and reinforced construction for sturdiness and low up-keep.
2. Simple, motor-driven tilting mechanism for safe and easy operation.
3. Low inertia electrode winches and roller-bearing electrode arms for high sensitivity of control.
4. High-powered and flexible transformer equipment for rapidity of melt.
5. Experienced attention to mechanical and electrical design to insure highest metallurgical performance and the lowest operating costs.

Also American Bridge fabricated and erected is the entire steel framework—including mezzanine and charging floors, track platforms, and crane runways—for the huge Tilting Open-Hearth and Electric Furnace building, and the almost as large Stockhouse in which raw materials are stored and handled.

★ This integrated completely up-to-date, high-alloy steel producing unit is typical of many of our wartime activities. The immeasurable increase in our resources, flexibility and experience we have acquired during these war years is yours to draw upon in your postwar planning and projecting.

AMERICAN BRIDGE COMPANY

General Offices: **Frick Building, Pittsburgh, Pa.**

District Offices in: **Baltimore · Boston · Chicago · Cincinnati · Cleveland · Denver · Detroit Duluth · Minneapolis · New York · Philadelphia · St. Louis**

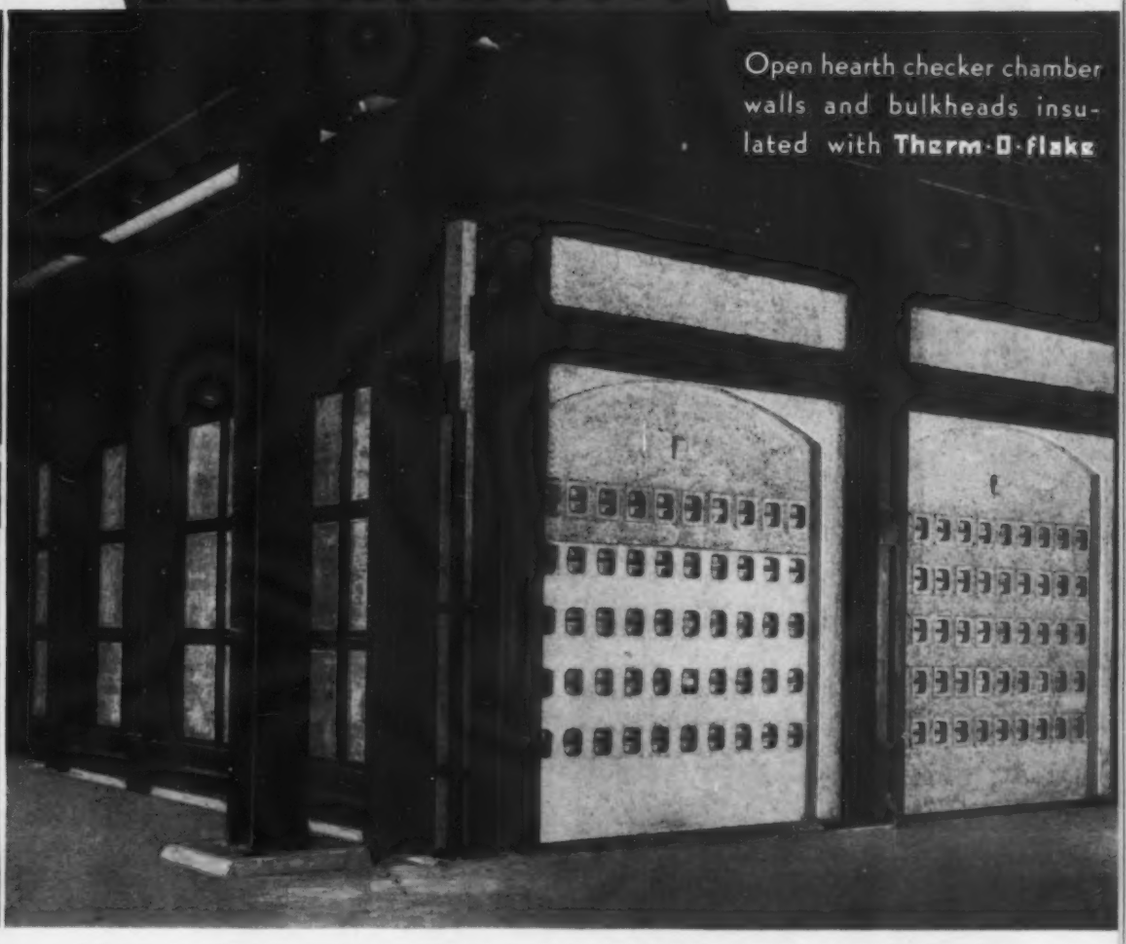
Columbia Steel Company, San Francisco, *Pacific Coast Distributors* **United States Steel Export Company, New York**

UNITED STATES STEEL

Another Therm-O-flake Installation

Open hearth checker chamber wall laid up in double thickness THERM-O-FLAKE insulating Brick with broken joints.

THERM-O-FLAKE Seal-Cote applied in screened panels overlaying THERM-O-FLAKE Brick. Wall is thus made impermeable, sealing out cold air.



Open hearth checker chamber walls and bulkheads insulated with **Therm-O-flake**

WHY Therm-O-flake is FIRST CHOICE for open hearth furnace Insulation!

Better control over air-fuel ratios—lower fuel costs—improved operating efficiency—are the results of insulating with **Therm-O-flake** products for the hearth, roofs and walls both above and below the charging floor. They are used in 8 out of 10 new open hearth plants because of their outstanding performance and reliability.

A thermal study of open hearth furnaces is available to show the actual fuel savings possible through **Therm-O-flake** Insulation.

For Greater Fuel Economy and Improved Working Conditions, SPECIFY Therm-O-flake

Seal-Cote "Double-Duty" Coating that seals out cold air infiltration. Sticks tightly to refractory brick even during shut downs.

Brick Featherweight Brick for back up insulation of slag pocket and checker chamber walls. Used in many plants to prevent warping and buckling of buckstays and skew back channel.

Concrete For hearth and bottoms. Twice the insulating efficiency of ordinary insulating concrete. Weighs approximately 40 pounds per cubic foot.

Illinois Clay Products Company

JOLIET, ILLINOIS

HIGH TEMPERATURE INSULATION

FOR OPEN HEARTH FURNACES · COKE OVENS · SOAKING PITS · BLAST FURNACE STACKS AND STOVES

POLLOCK LADLES AND CARS

WERE CHOSEN FOR THE NEW SOUTH CHICAGO STEEL PLANT . . . . .

The William B. Pollock Company's outstanding position in the field of hot metal and slag handling equipment is again demonstrated by the fact that thirty 100-ton all welded ladles, two ladle transfer cars, and nine 330 cubic foot motor driven slag pot transfer cars are in operation at the new South Chicago plant.

100 ton Pollock all welded steel mill ladle and transfer car

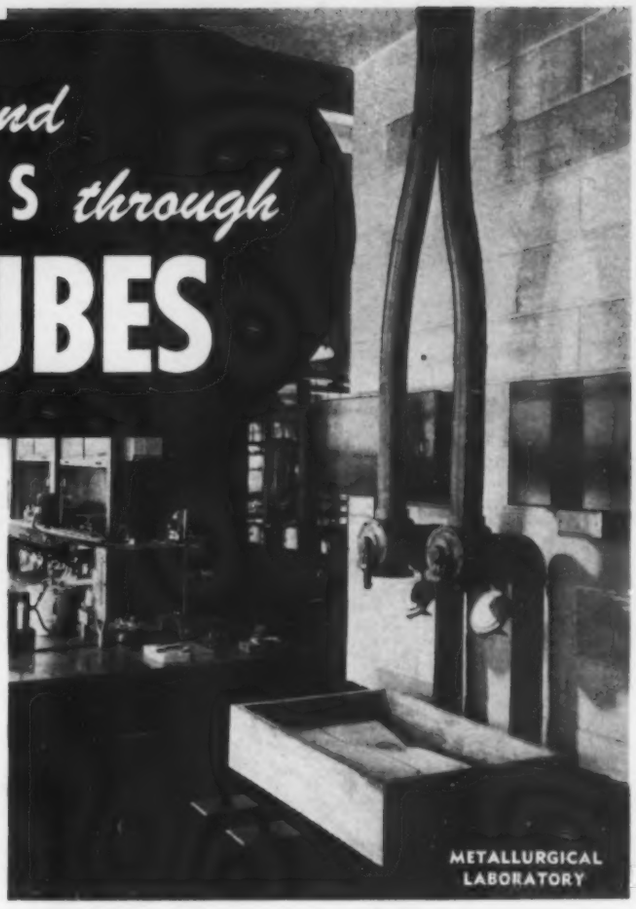
More than half of all the hot metal cars and ladles and cinder cars for America's new war plants are Pollock designed and Pollock built. The Pollock Company would welcome your inquiries in regard to the modernization of your iron and steel handling equipment.

330 cubic foot motor driven slag pot transfer car

THE WM. B. POLLOCK COMPANY

YOUNGSTOWN • OHIO

Accurate, Split-Second
CONTROL OF HEATS *through*
LAMSON TUBES

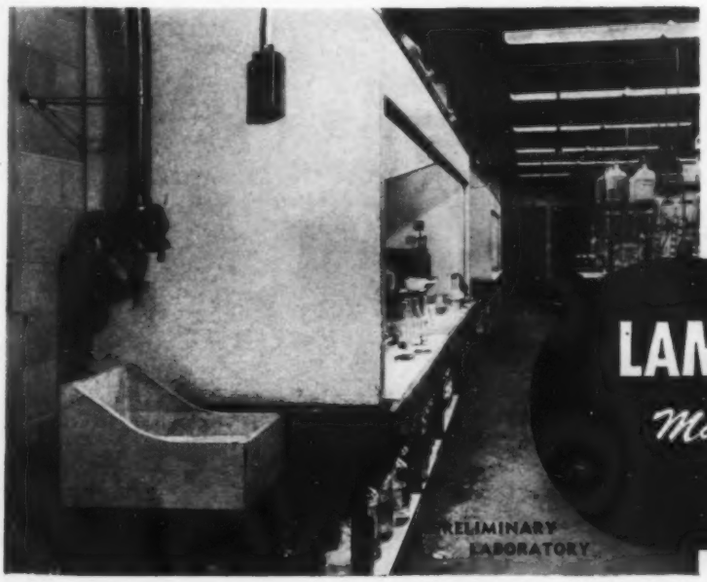


Recent Steel Plant installation carries steel samples weighing up to 2 lbs. over distance of 3,000 ft.

The Problem: To keep the Metallurgical Laboratory in constant touch with the Metallurgical Forge Shop in a distant building. Also to enable the Metallurgical Laboratory to maintain fast communication with the Preliminary Laboratory in the Tilting and Electric Furnace Building. Drillings from samples on the furnace floor must reach the Laboratory *at once*, and a *written analysis*, leaving no room for error, must be returned.

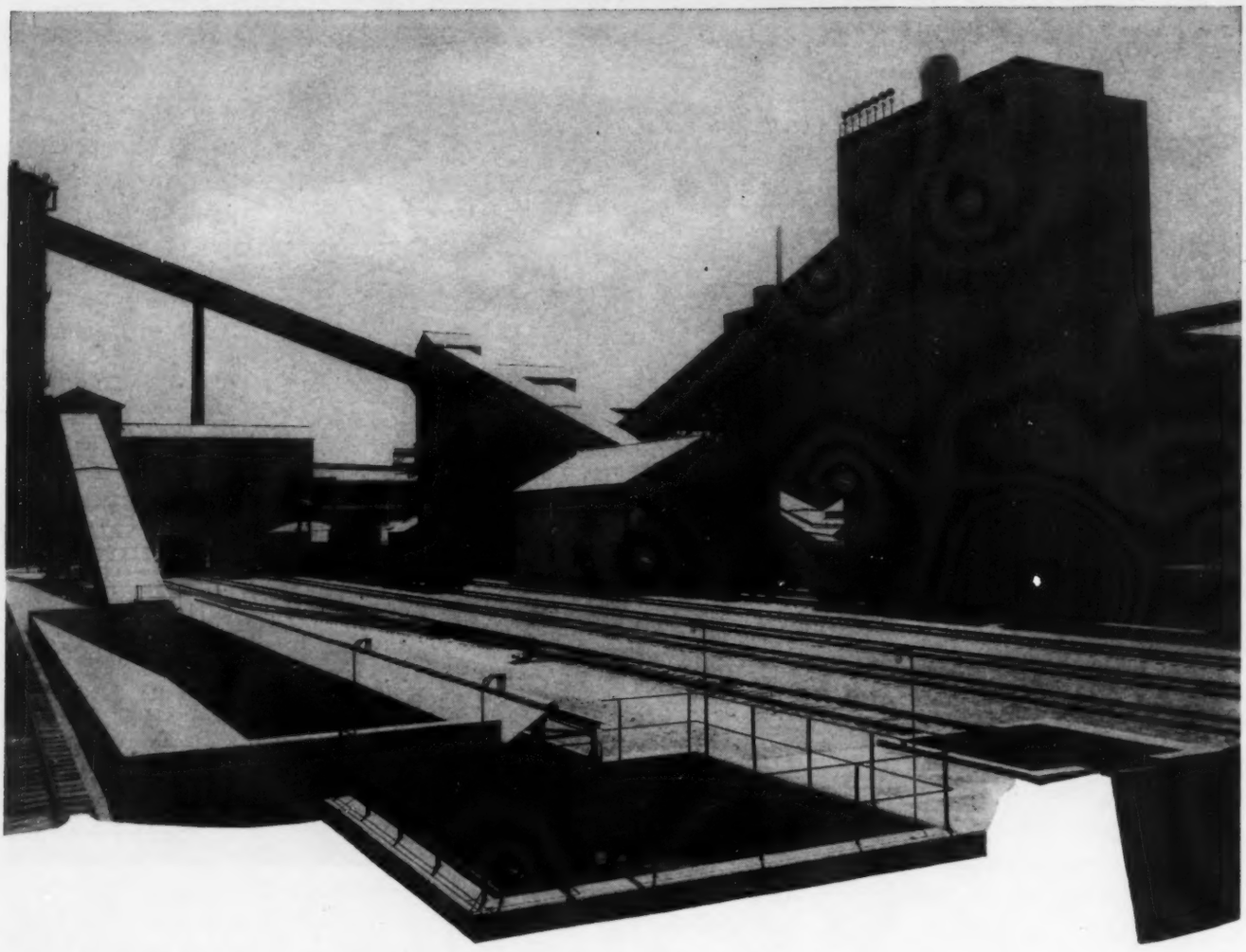
The Old Way: Messengers, on foot, carried the samples—with subsequent loss of time and production. Telephone analyses, subject to misunderstanding and error—or the slow messenger service carried back the report.

The Solution: LAMSON TUBES now carry Hot drillings to the Laboratory at a speed of 30 to 50 ft. per second! The same tube, reversed, speedily returns an accurate, written analysis. No errors—no time loss—with Lamson Dispatch Tubes.



WRITE TODAY!
to learn how Lamson can take the bottlenecks out of production

LAMSON CORPORATION
Makers of Conveyors and Tubes
SYRACUSE 1, N. Y.



AT THE COKE PLANT

In the materials-handling system designed by Heyl & Patterson, coal from the railroad cars is either conveyed to storage under the ore bridges, or crushed, blended and delivered to the larry bin at the coke ovens.

The coke is conveyed from the coke wharf, crushed, screened and delivered to the blast furnace coke bins.

AT THE STORAGE YARD

The two 17 net ton Heyl & Patterson ore bridges pictured on the opposite page include many advancements in design and construction. Built into these bridges are extra sturdiness, new provisions for low maintenance, the latest safety features, and, in particular, a type of control that assures the greatest ease and simplicity of operation.

Special-design units built by Heyl & Patterson for the coke plant, include Bradford Coal Breaker and Synchronized-roll Coke Crusher.

ENGINEERED BY *Heyl+Patterson*

At this new blast furnace plant in the Chicago district, Heyl & Patterson was responsible for the design, fabrication, and erection of the two ore bridges and the coal and coke handling equipment for the by-product coke ovens.

These materials-handling facilities represent one of the many contributions by Heyl & Patterson to the recent expansion of blast furnace capacity.

During the last three years this organization has built a total of nine ore bridges. These are in addition to the construction of railroad car dumpers, car haulage systems, pig-casting machines and other equipment essential to blast furnace operation. In this way the specialized experience of Heyl & Patterson has helped to answer the insistent call for steel.

H & P PRODUCTS
FOR THE
STEEL INDUSTRY

ORE BRIDGES
•
RAILROAD CAR DUMPERS
•
PIG CASTING MACHINES
•
SKIP HOISTS
•
COAL and COKE HANDLING PLANTS
•
BOAT LOADING and UNLOADING PLANTS
•
COAL and COKE CRUSHERS

HEYL & PATTERSON INC.

50 WATER STREET PITTSBURGH, PA.

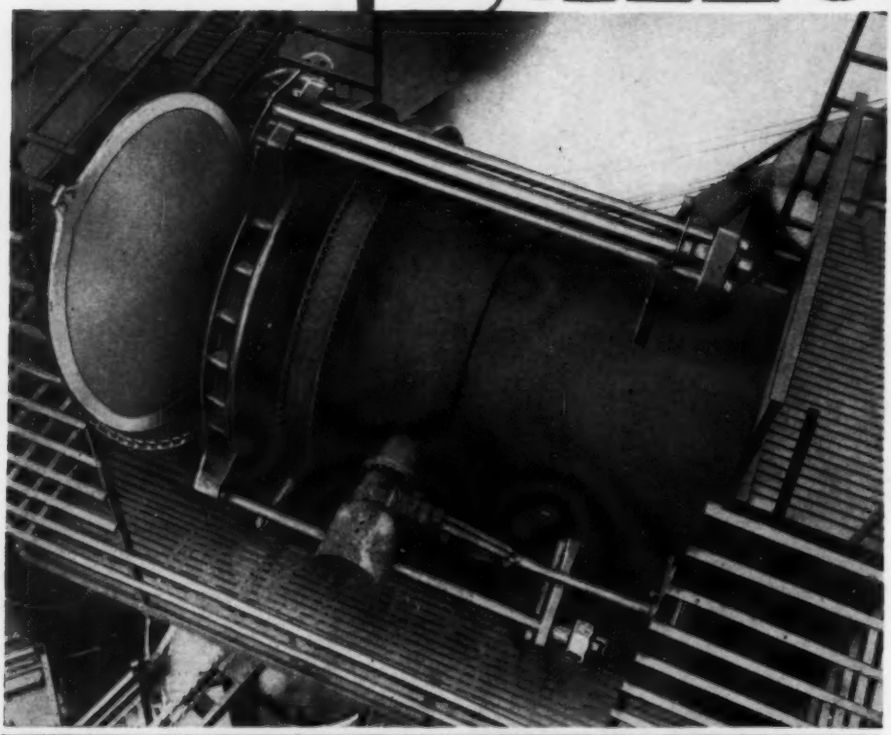
Export Representative WONHAM Inc. *44 Whitehall St., New York*

DEPENDABLE *Safety*

Bailey

THERMAL EXPANSION

GOGGLE VALVE



Successfully Adapting the Sound Theory of

- **EXPANSION**
- **CONTRACTION**

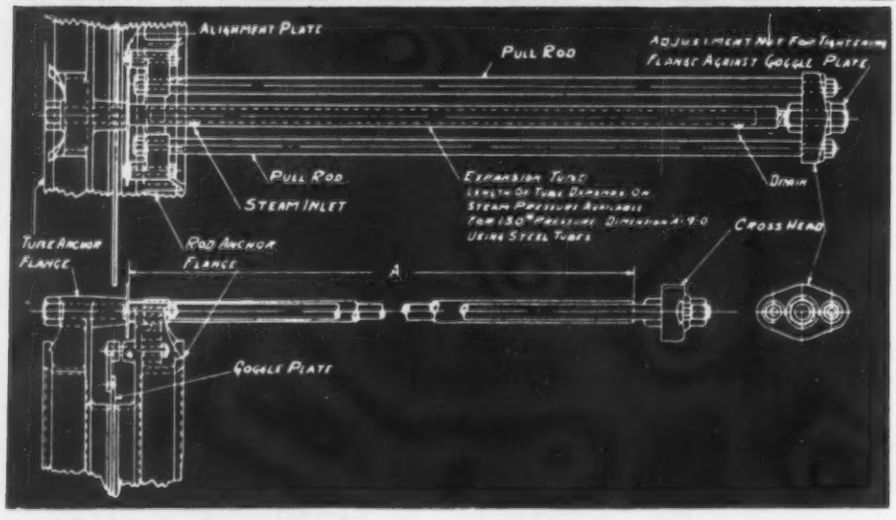
to

SAFELY SEAL..

BLAST FURNACE GAS WASHER

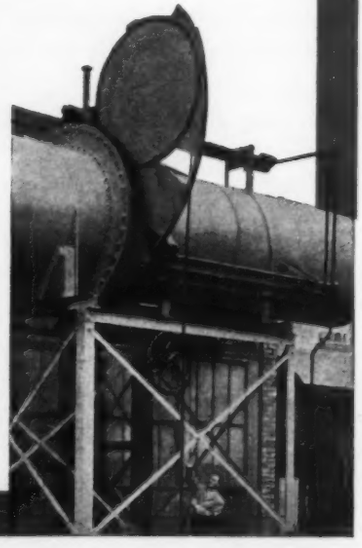
and

BOILER PLANT GAS MAINS



Leadership through **QUALITY**

120" Bailey Thermal Expansion Valve being operated manually.

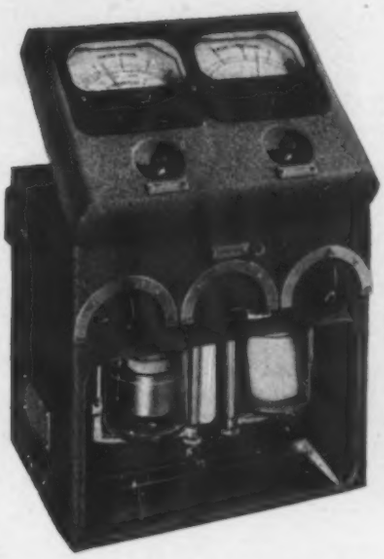


3 WAY OPERATION FOR PLUS SAFETY . . . ELECTRIC, STEAM or MANUAL

Powerful thermal expansion rods resistlessly lock the gas-seal by *contraction* . . . release by *expansion*. Three way operation assures complete control under any emergency. Rugged, dependable construction, economy-proved by world-wide installations under the most exacting requirements. To cut maintenance costs . . . with safety, specify *Bailey Thermal Expansion Goggle Valves.*

WILLIAM M. BAILEY COMPANY *Engineers* **PITTSBURGH, PENNA.**

FREE to Industry



THE CITIES SERVICE INDUSTRIAL HEAT PROVER—a new instrument developed by Cities Service to enable those engaged in the oxygen control of furnace atmospheres to achieve greater combustion efficiency at less cost.

Tilting hearth furnaces in the new steel plant of a leading producer in the Chicago District.

To help increase production, CITIES SERVICE offers Industry a FREE Industrial Heat Prover Test!

THIS test helps to solve combustion problems, reveals how fuel can be conserved, and the quantity and quality of the product increased.

Is your industrial plant equipped with combustion control equipment?...Even if your answer is "yes," you may not be getting *accurate* combustion control.

The way to make sure is to take advantage of this new Cities Service offer: **Without charge or obligation, a complete combustion control test with the exclusive Cities Service Industrial Heat Prover is available on request in most of the important industrial cities EAST of the Rocky Mountains.**

The Cities Service Industrial Heat Prover has been thoroughly tested on practically every type of combustion equipment in this country and with every kind of fuel.

Accurate combustion analyses made as a result of the Cities Service Industrial Heat Prover tests have resulted in considerable savings in fuel costs, have reduced repairs and replacements on furnace linings, crucibles and refractories due to flame corrosion...and have led to increased production of better and more uniform products.

Wire or phone your nearest Cities Service office or mail the coupon today—for a Cities Service Industrial Heat Prover test in your own plant conducted by a member of the Cities Service engineering staff.

MAIL THIS COUPON ➔
today for an
Industrial Heat Prover Test
of your equipment—
at no cost or obligation
to you

CITIES SERVICE OIL COMPANY
919 N. Michigan Ave.,
Chicago 11, Ill.

Gentlemen: Please get in touch with me regarding your Industrial Heat Prover Test.

Name_____
Title_____
Company_____
City_____

(Available only in Cities Service Marketing Territory *East* of the Rocky Mountains.)

CITIES SERVICE OILS
ONCE-ALWAYS

CITIES SERVICE OIL COMPANY
ARKANSAS FUEL OIL COMPANY

★ Flexibility... program control... quality tonnage, all essentials to war effort, highlight the features of this most modern of soaking pit installations.

Not only is it large in the number of pits, but each pit ranks in individual size—2,800 cubic feet. Electric steel ingots ranging in size from 10,000 lbs. to 34,000 lbs. each are being uniformly heated in minimum time. The total installed capacity is approximately 2,000 tons.

Each of the 24 Surface Combustion Soaking Pits is equipped with automatic temperature and combustion controls. This "Program Control" feature is used to maintain the high quality of the electric alloy steel.

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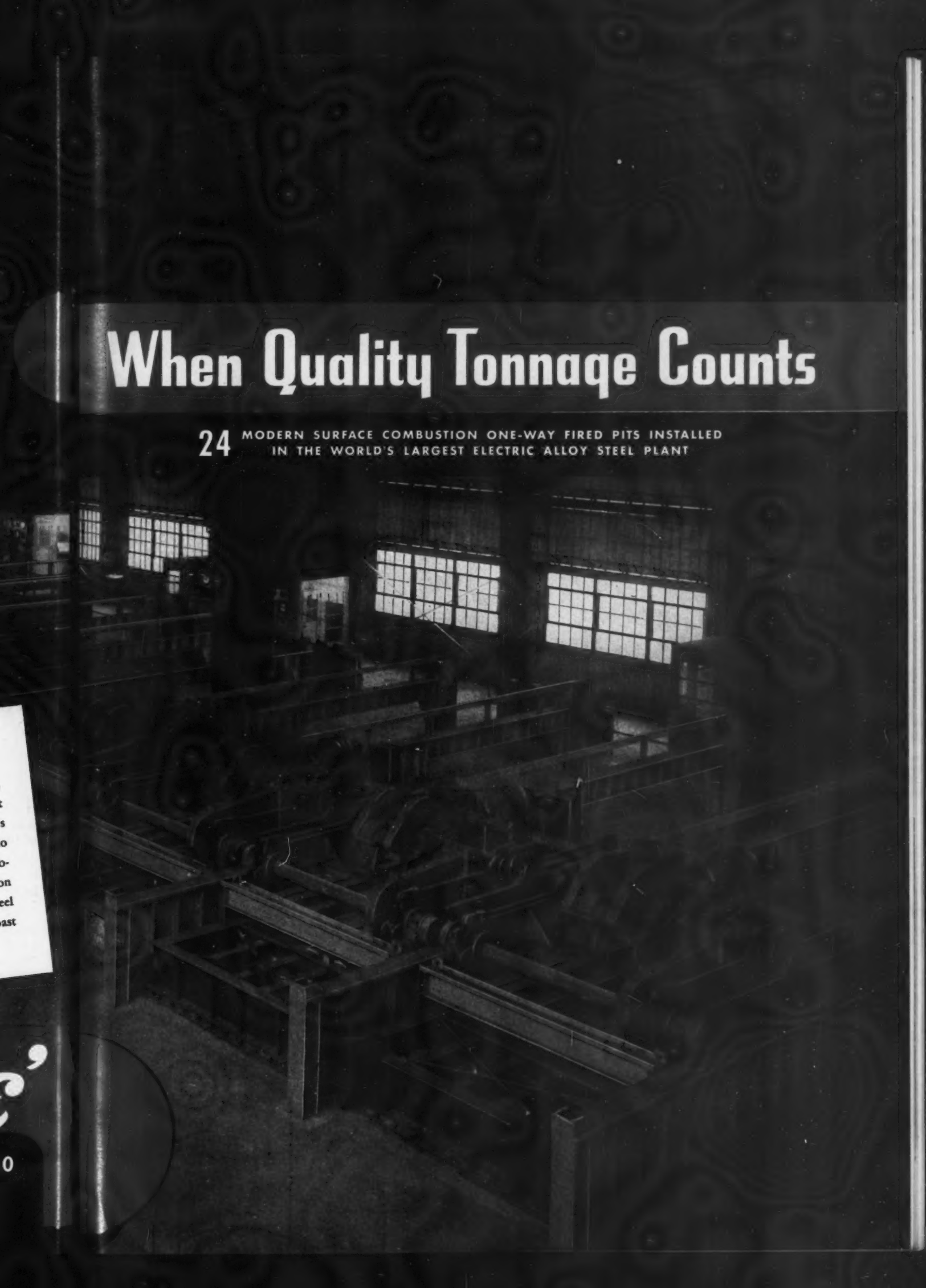

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The PLYMOUTH FLEXOMOTIVE is as modern, rugged and efficient as the great mills which it serves . . excelled performance for steel mill transportation

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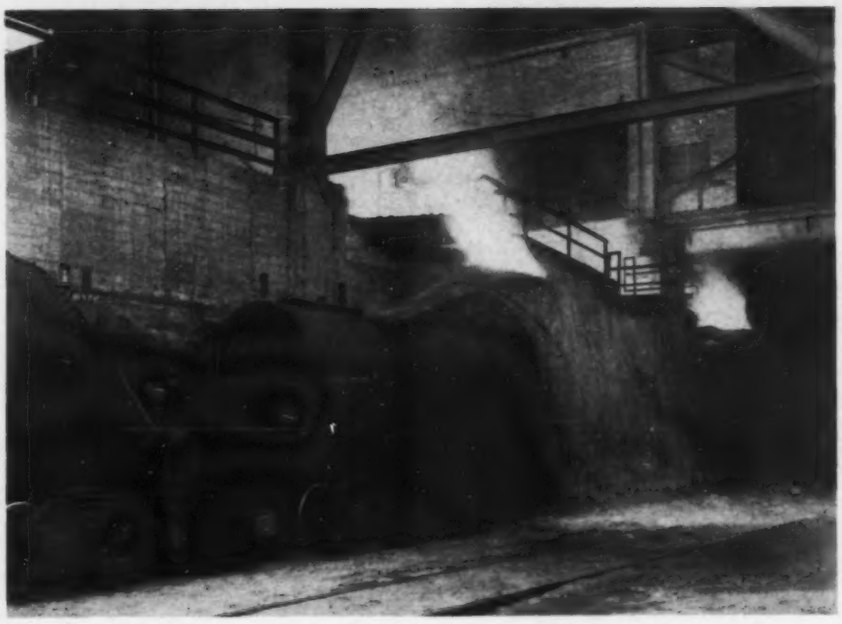

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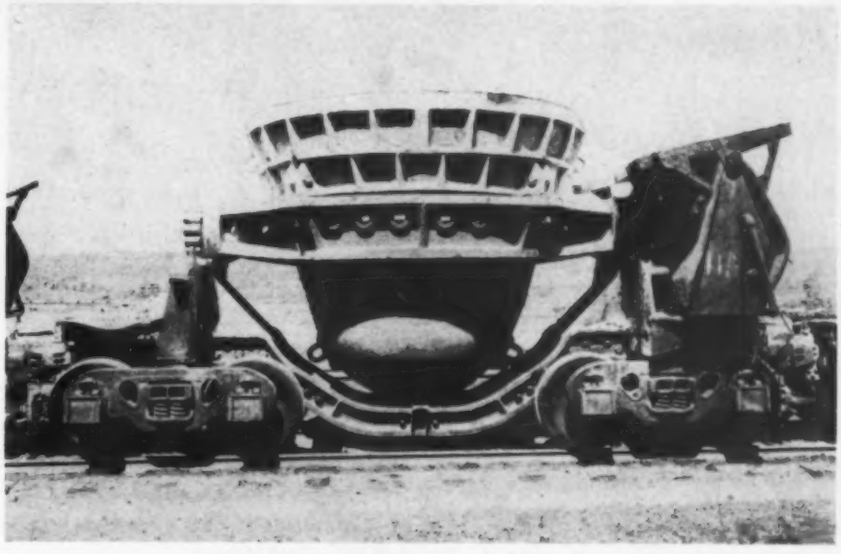

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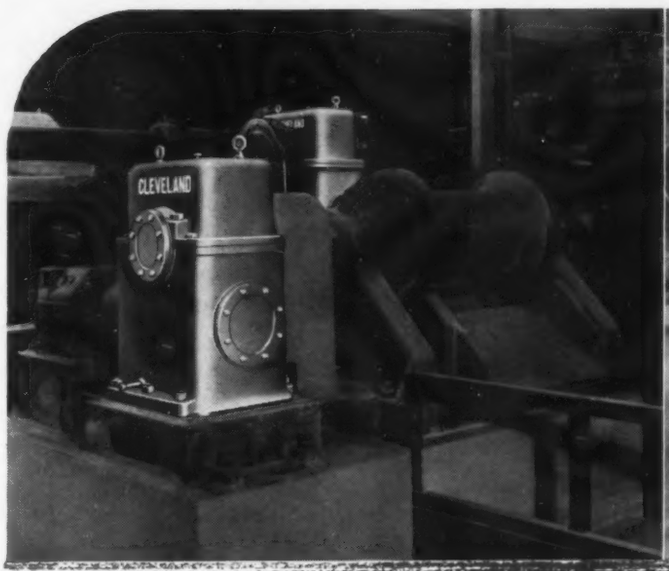

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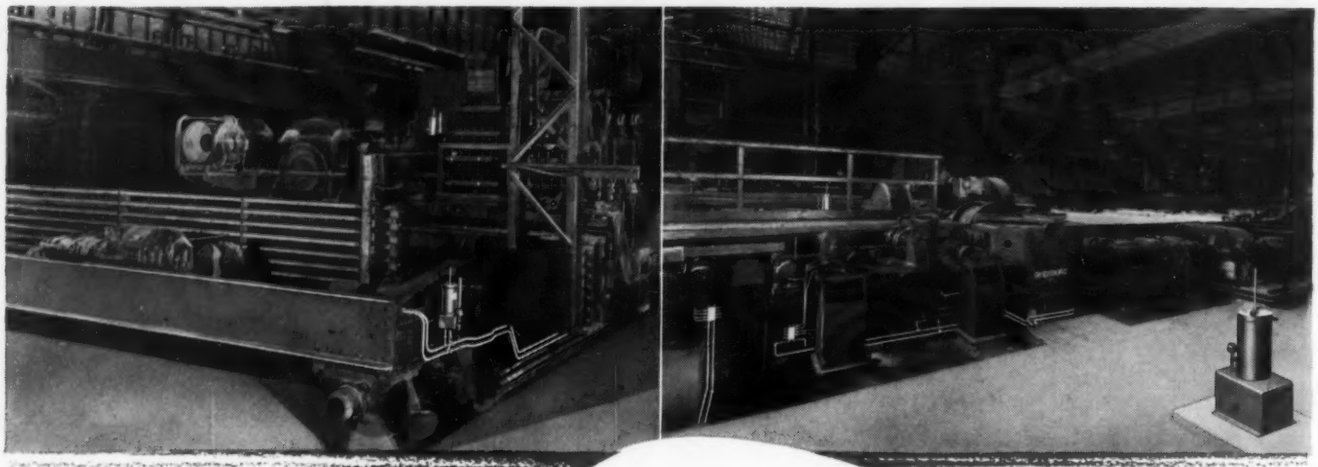

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CENTRALIZED SYSTEMS OF LUBRICATION

Methods AND Equipment FOR Induction Heating

. . . . induction heating will continue to progress in postwar production . . . . experience will lead to applications now thought impractical . . . . research will remove some present limitations . . . .

by C. C. Levy*

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

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▲ THE mathematical analysis on which the art of induction heating is based is somewhat complicated, but there are several very interesting physical facts and relations which can be brought out when the fundamental equations are given.

For example, let us take the simple scheme for inductively heating by longitudinal flux a non-magnetic cylinder, say one of brass. This arrangement is shown in Figure No. 1, where the hollow tubular inductor coil surrounding the cylinder is connected to a source of alternating current as shown. When current flows in this coil, alternating flux is set up as shown, and induced voltages produced in the cylinder. These induced voltages produce currents commonly called "eddy currents" which heat the cylinder due to the resulting I^2R loss. This action is similar to that in any transformer except that the cylindrical piece in this case not only carries the magnetic flux but is also the secondary winding, in which the induced currents flow.

It has been established that the induced currents in such a cylinder will decrease in magnitude, and will vary in phase angle progressively from the surface of the cylinder toward its center. The resulting change in current density is shown in Figure 2 which represents a cross section of the cylinder.

It has further been established that if we assume the induced currents to be uniformly distributed over a depth (δ) below the surface as shown by the dotted line in Figure 2, the effect so far as the heating of the cylinder is concerned, would be the same as that due to the actual distribution of the current. This depth (δ) which is called the "depth of penetration" is one of the key facts in induction heating applications. The resistance of the secondary circuit can readily be calculated, knowing the resistivity of the metal when we have determined this depth of penetration. The current in the single turn secondary circuit is readily determined by the turn ratio when the current in the primary exciting coil is known. The I^2R loss in the secondary circuit is thus readily determined.

Depth of penetration is a function of the resistivity (ρ) of the material, of the permeability, ($\mu = 1$), and of the frequency. These quantities are related in the classical equation for non-magnetic materials.

$$\delta(\text{cm}) = 5030\sqrt{\frac{\rho}{\mu f}} \qquad (1)$$

Figure 3 shows "depth of penetration" plotted against frequency for several of the commoner non-magnetic materials.

The general equation for power input to a non-magnetic cylinder with a coil that is long compared to the diameter of the cylinder has been established in the following equation:

$$\text{watts per cm}^3 = \tfrac{1}{2}\,\mu\,H_o^2 \times f \times G_a\,(Ka) \times 10^{-7} \qquad (2)$$

Presented before A. I. S. E. Detroit District Section Meeting, November 9, 1943

*Deceased

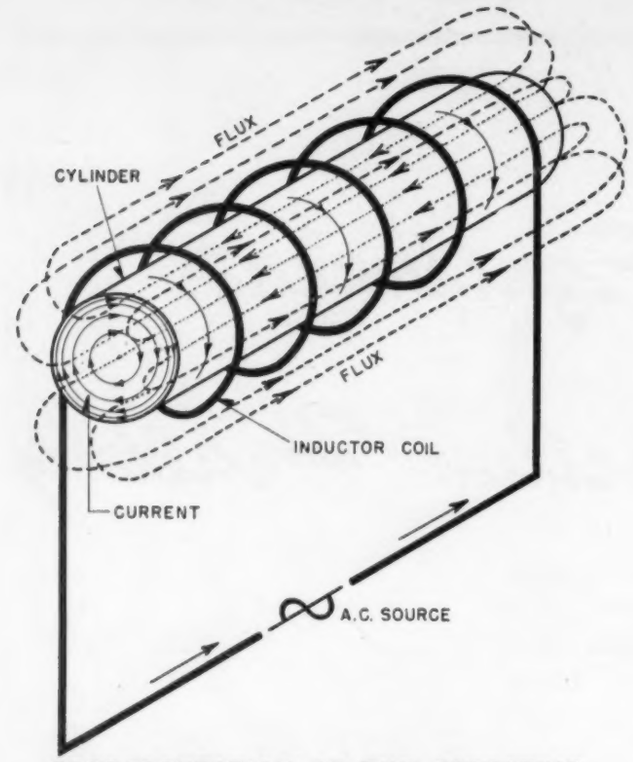


Figure 1 — Arrangement for inductively heating solid cylinder.

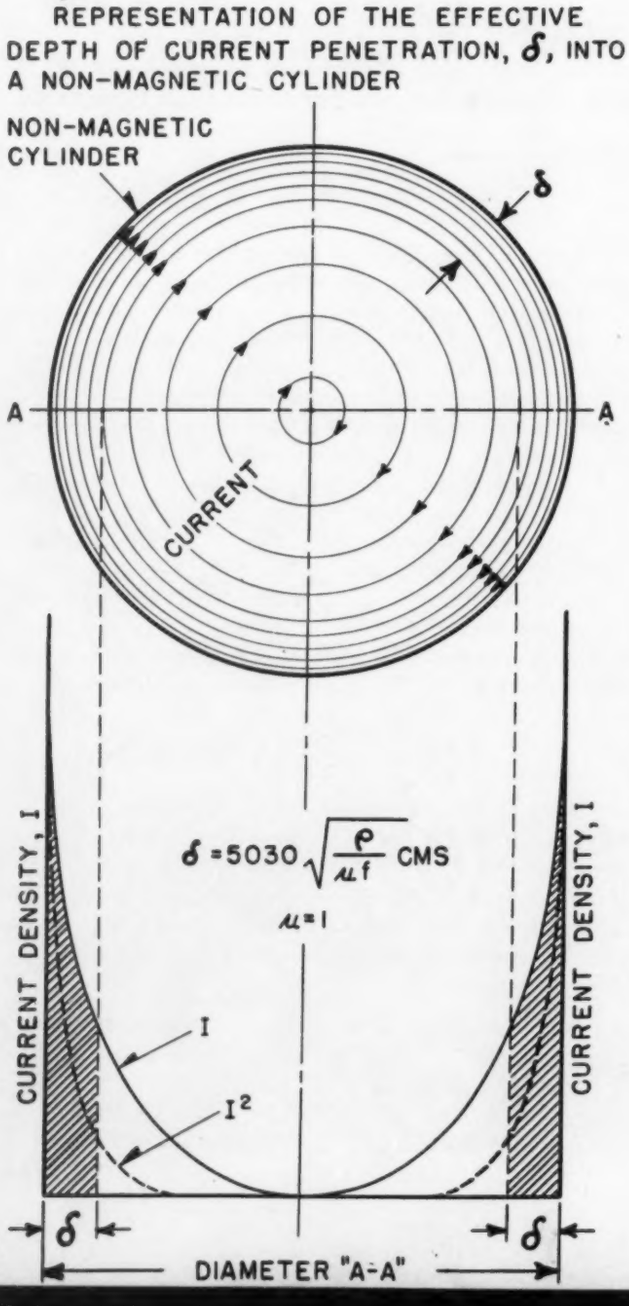


Figure 2 — Cross section of cylinder showing current distribution with induction heating.

where H_o is the peak value of magnetizing force in oersteds at the surface of the cylinder, and f is the frequency.

G_a (Ka) is a function which combines the effect of the varying power factor of the induced currents within the cylinder. This function, which is a complicated mathematical expression, is usually plotted as shown in Figure 4 against a parameter Ka — where a is the radius of cylinder and $K = \sqrt{\frac{8\pi^2 \mu f 10^{-9}}{\varrho}}$

This relation can be used to determine the desirable frequency to use for an induction heating problem when the magnetizing force is given. The general equation (2) for power input shows that for a given magnetizing force, the watts per unit volume will have a maximum value at a frequency which results in the maximum value for this factor G_a (Ka). The curve in Figure 4 reaches a maximum when $K \times a = 2.5$, consequently we equate $K \times a$ to 2.5 and solve for the frequency (f) which will then give the maximum value of this factor.

The value of frequency so determined has been called the optimum frequency though it is not necessarily the correct frequency to use. This is because it is more economical to sacrifice some of the theoretical advantage so obtained to permit use of a lower or higher frequency which is standard.

Since this factor G_a (Ka) involves the diameter of the cylinder, it is easier to understand why variation in the size of the piece results in variation in optimum frequency. Figure 5 illustrates this point in showing the variation of optimum frequency with diameter of a non-magnetic cylinder.

The heating of a magnetic material, such as steel, introduces two complications. One is the fact that at the critical temperature, sometimes called the Curie point (approximately 1250 F to 1300 F, steel becomes non-magnetic, and the second is that at lower temperatures, its permeability varies with temperature. These facts make it necessary to modify the general equations for power input for the case where magnetic materials are heated to a temperature less than the critical temperature. The simplest equation for such cases is the well-known Rosenberg equation which is based on certain assumptions, but is sufficiently accurate within certain limits. This equation can be written:

$$\text{watts per cm}^3 = \frac{3.36 \times 10^{-4}}{d} \sqrt{BH_o{}^3 f \varrho} \qquad (3)$$

Where d is the diameter of the cylinder in cm.

This equation applies only if the depth of penetration is small compared to the radius of the cylinder, and the value of δ should always be checked before using the equation.

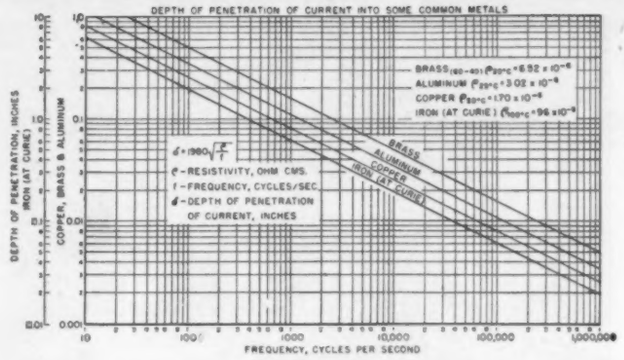

DEPTH OF PENETRATION OF CURRENT INTO SOME COMMON METALS
BRASS (60-40) ρ 20°C = 6.92 x 10⁻⁶
ALUMINUM ρ 20°C = 3.02 x 10⁻⁶
COPPER ρ 20°C = 1.70 x 10⁻⁶
IRON (AT CURIE) (ρ 700°C = 96 x 10⁻⁶
δ = 1980 √(ρ/f)
ρ - RESISTIVITY, OHM CMS.
f - FREQUENCY, CYCLES/SEC.
δ - DEPTH OF PENETRATION OF CURRENT, INCHES
BRASS
ALUMINUM
COPPER
IRON (AT CURIE)
DEPTH OF PENETRATION, INCHES IRON (AT CURIE)
COPPER, BRASS & ALUMINUM
FREQUENCY, CYCLES PER SECOND

Figure 3 — Depth of penetration as a function of frequency.

(above)

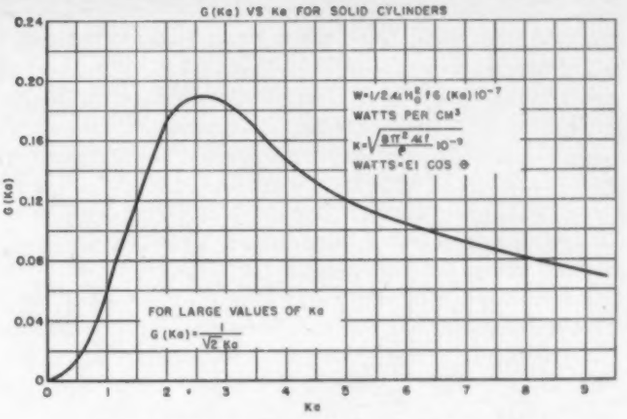

G (Ka) VS Ka FOR SOLID CYLINDERS
G (Ka)
Ka
W = 1/2.4π H₀² f 6 (Ka) 10⁻⁷
WATTS PER CM³
K = √(8π² 4πf / ρ) 10⁻⁹
WATTS = EI COS Θ
FOR LARGE VALUES OF Ka
G (Ka) = 1 / √2 Ka

Figure 4 — Values of G_a function plotted against K (a).

(above right)

In the case of strip, the equation is:

$$\text{watts per cm}^3 = \frac{1.68 \times 10^{-4}}{t} \sqrt{BH_o\ {}^3f\rho} \qquad (4)$$

where t is the thickness of the strip in cm.

Since magnetizing forces used are always of such value that saturation will result, the value of B = 18,000 gausses is used in these equations.

Since temperatures which exceed the critical temperature where magnetism is lost, are frequently met in practical applications, the equations given for non-magnetic materials can be used with safety, because the heating during the magnetic stage will give a higher power input per unit volume than during the non-magnetic stage, so results will always be on the safe side.

Other interesting facts can be deduced from fundamentals. For example, good electrical conductors, such as copper, are difficult to heat inductively. The depth of penetration in copper is relatively large, consequently the resistance is quite low, so that even with a large secondary current, the total I^2R is low. In fact, we can readily see that we will get an efficiency of 50 per cent in heating copper, because the losses in the inductor coil are equal to the useful heat developed in the copper as long as the resistivity of the coil and the work are so nearly the same.

This brief general discussion of theory lays no claim to being complete or original; it is presented with the hope that it will make the further study of this exceedingly interesting subject more general. The fact is that with so many very interesting cut and try experiments, which can be made quite easily once there is available a source of high frequency; the theoretical and more fundamental attack is frequently neglected or entirely ignored.

EQUIPMENT

No single type of power supply or heating unit is suitable for all induction heating processes. Frequencies

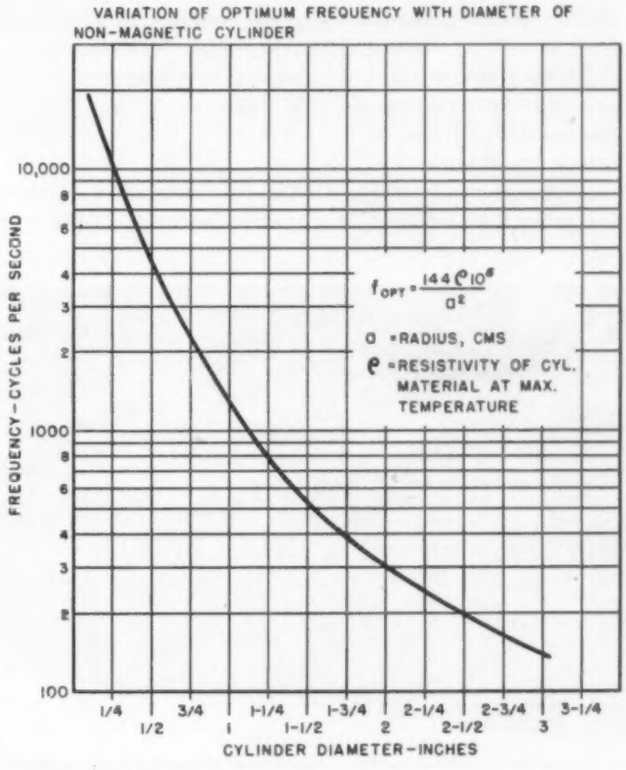
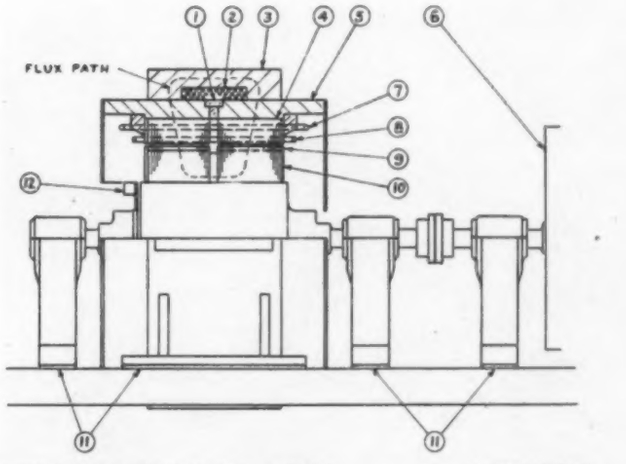

VARIATION OF OPTIMUM FREQUENCY WITH DIAMETER OF NON-MAGNETIC CYLINDER
FREQUENCY - CYCLES PER SECOND
f OPT = 144 ρ 10⁸ / a²
a = RADIUS, CMS
ρ = RESISTIVITY OF CYL. MATERIAL AT MAX. TEMPERATURE
CYLINDER DIAMETER - INCHES

Figure 5 — Variation of optimum frequency with diameter of non-magnetic cylinders.

▲

Figure 6 — Cross section of inductor generator.



which have been used at one time or another include 60, 360, 500, 960, 2000, 3000, 9600 and 10,000 cycles, all of which except for 60 cycles require motor-generator sets; higher frequencies from 25,000 to 100,000 cycles are obtained from spark gap converters and vacuum tube oscillators; and still higher frequencies are supplied only from vacuum tube oscillators.

At first sight, standardization over such a wide range of frequency would appear rather difficult. However, several conditions operate to limit the number of frequencies used. These are: (1) Cost of developing a new motor generator set for each new frequency involving new tools, etc.; (2) the fact that frequencies are not so critical, but that a few well chosen frequencies will adequately cover the range. As a result only the following motor generator frequencies are now in general use: 960, 3000, 9600 and 10,000 cycles. In the oscillator field, no standards as yet exist; but here again economic reasons, and communication restrictions on the frequencies which can be used will result in relatively few frequency designs.

Motor generator sets — Of the total installed capacity for induction heating, the greater portion by far consists of motor generator sets. Conventional salient pole designs, used at first for the high frequency generator, were satisfactory for 500 and 960 cycles but were unsuitable for higher frequencies because rotor diameters were limited by the peripheral speed, and the pole pitch could not be reduced below a certain minimum value. The inductor type high frequency generator was then adopted. This type of machine had previously been developed as a high frequency source in the field of wireless telegraphy, it was increased in capacity for induction heating and is now universally used.

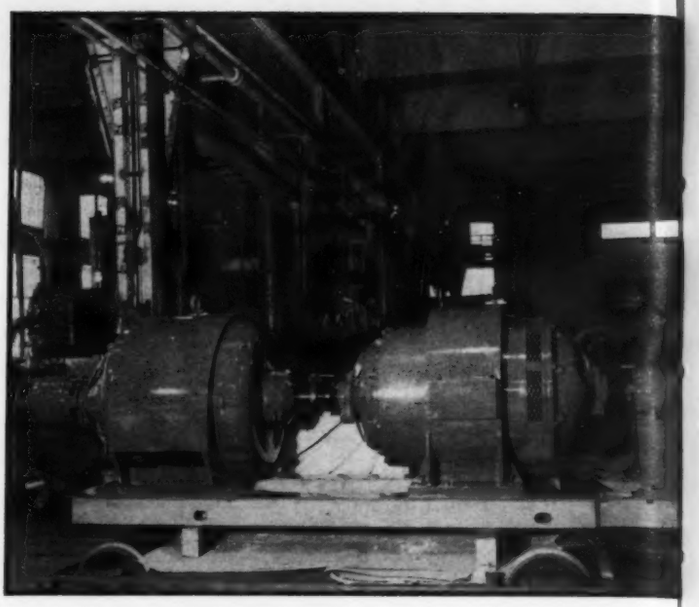


Figure 7 — Motor generator set of 350 kw, 960 cycles.

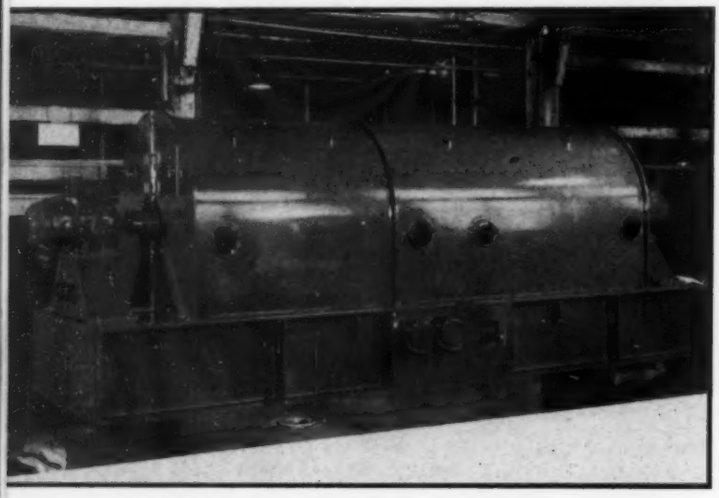


Figure 8 — Motor generator set of 600 kw, 3000 cycles, with enclosing covers.

Figure 9 — Motor generator set shown in Figure 8, but without enclosing covers.

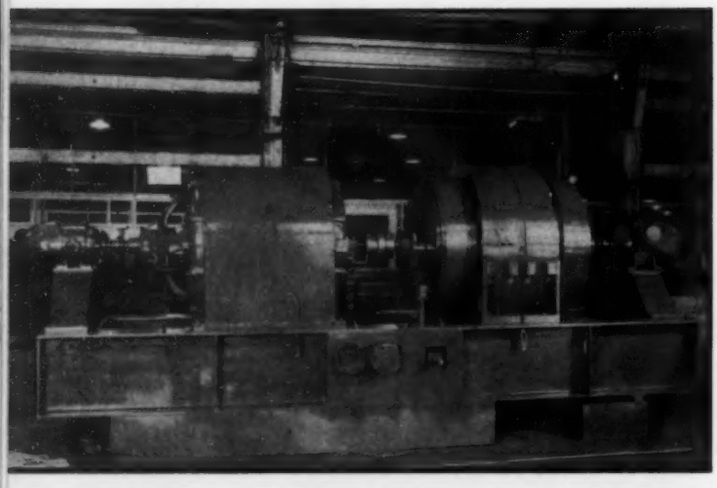


Figure 6 shows a cross section of a typical inductor type generator. There are no windings on the stator and the rotor is slotted so as to produce an air gap with varying reluctance as the rotor is driven in the field set up by the large circular exciting coil. Due to absence of windings on the rotor the pole pitch can be made quite small and when high speeds are used the diameter of the rotor can be kept within reasonable limits.

A typical open type unit in which the generator is rated at 350 kw, 960 cycles is shown in Figure 7. The stator of this unit is water cooled by means of pipes imbedded in the iron just below the stator punchings. It has been found by experience, that there is a distinct advantage in the use of water as an auxiliary to air as a means of removing the losses. When complete reliance is placed on air, it is absolutely necessary to clean the ventilating air, to avoid clogging of important air passages in the unit; when water is used only a portion of the losses are removed by air, and the sets are not so dependent on air for cooling.

Further development in the construction of these units is illustrated in Figures 8 and 9 which show a 600 kw 3000 cycle enclosed unit, with and without the enclosing covers. The housing includes the coolers for the ventilating air which in this case is recirculated. Such designs are self contained and may be located anywhere in a factory without ventilating ducts or any consideration of the surrounding air.

Figure 10 shows an enclosed design arranged for hydrogen cooling, with a special design of motor and generator to produce a high frequency set of high efficiency and excellent performance. The generator is rated at 500 kw, 9600 cycle and is driven by a two-pole induction motor. The use of hydrogen for an industrial motor generator set of this type was an innovation, but it has been very decidedly justified; many units of this size are in service, and units of 1250 kw capacity are now being built.

Figure 11 shows a 20 kw motor-generator set of approximately the same frequency 10,000 cycles but at the other end of the scale in size. These sets represent a special development for compactness since they are mounted in the heat treating cabinets made for surface hardening and other applications. This type of integral design with two bracket bearings has become quite popular for small capacity units from 20 kw up to 200 kw at frequencies of 2000 and 3000 and 10,000 cycles. Figure 12 shows a set of this type for 50 kw, 3000 cycles which operates on an induction furnace.

Spark gap converters — This is a high frequency generating device of quite a different type. It was the first power supply for induction heating having been used by Dr. Northrup in his early experimental work in this field.

When it was abandoned for the motor generator set, the path of induction heating turned from relatively higher frequencies to the relatively lower frequencies in which it stayed for many years. The recent demand for higher frequencies has revived interest in this type of generator. The circuit shown in Figure 13 is the well known one used originally in spark gap wireless transmitters, but adapted to the larger capacity needed in industrial heating. It covers a range in frequency from 50,000 to 150,000 cycles depending on the constants of the circuit. The capacity of the spark gap is its limitation. A theoretical maximum useful output of 30 kw is all that can be expected of present designs. The equipment is all of the static type and employs no tubes; the spark gap however has a limited life and is difficult to maintain in the adjustment needed for maximum efficiency.

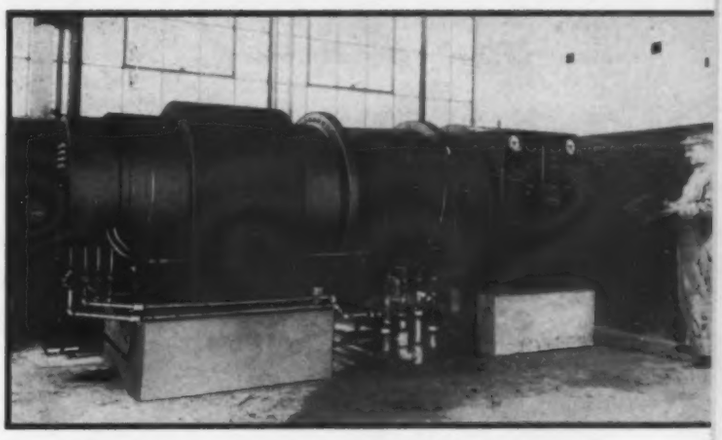


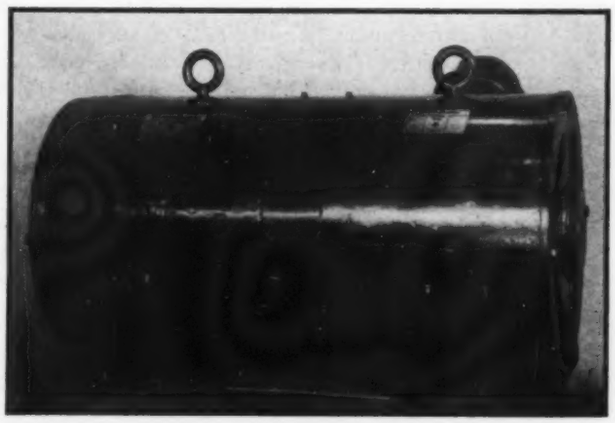
Figure 10 — Hydrogen cooled motor generator set of 500 kw capacity.

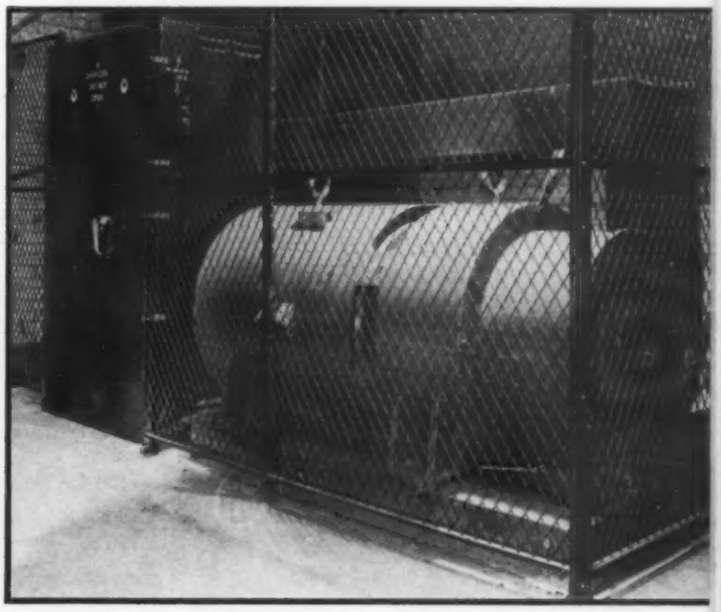
Electronic oscillators — Electronic high frequency generators are the most recent type of power supply for induction heating. Oscillators have been used for radio broadcasting stations but in general do not exceed 50 kw in capacity, and the circuits employed are usually more complicated than is necessary in an industrial application for supplying high frequency energy. Alternating current at sixty cycles is rectified to direct current and fed to the oscillator tubes. It is then converted by a simple standard electronic oscillating circuit to energy at the desired frequency according to predetermined characteristics of the circuit. This high frequency energy is then supplied to the heating load by some suitable means of coupling.

Vacuum tube oscillators at present are not economical in the range of frequencies below 50,000 cycles and are best applied where frequencies required exceed this value. In the applications for the tin reflowing process to be discussed later, a frequency of 200,000 cycles has been found very satisfactory. Although only

Figure 11 — Motor generator set of two-bearing type, rated 20 kw, 10,000 cycles. ↓

Figure 12 — Another motor generator set of two-bearing type, rated at 50 kw, 3000 cycles. →





recently applied to inductive heating, oscillator installations are being made on a very large scale; for example, electrolytic tinning lines operating at 1000 feet per minute are now being supplied with 1200 kw oscillators for reflowing tin.

To supply such large blocks of energy a number of oscillator units of smaller capacity fed by a single large rectifier are used. Oscillator tubes may be either water cooled or air cooled. For the larger size units, 100 kw or more, water cooled tubes are used. The oscillator tank circuit inductance and the inductor coil are also water cooled in many applications.

Water cooled capacitors — The induction melting furnace operates at a very low power factor, approximately 10 per cent. Induction heating loads are better but their power factor is still low. It is uneconomical to design generators to supply the total kva of such loads, and capacitors are an essential part of the equipment to neutralize the lagging kva of the load. A 60 cycle capacitor has a kva rating determined by the permissible voltage stress on the insulation, and the ability of the case to dissipate the losses by natural radiation. If we hold the voltage stress constant, but increase the frequency, the kva drawn from the line increases in direct proportion, but the losses also increase in the same proportion. By using an efficient method of water cooling to dissipate these losses, it is possible to operate capacitors at a very much increased kva rating. For example a 230 kva, 9600 cycle capacitor unit with internal water cooling is the same in size as a 15 kva air cooled 60 cycle.

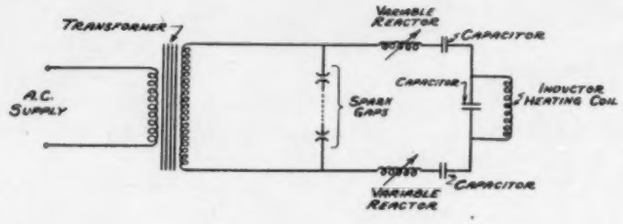


Figure 13 — Circuit for spark gap converter.

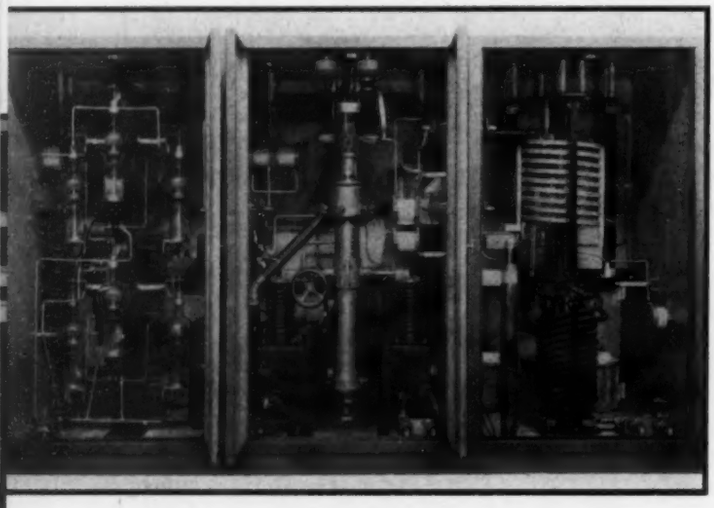
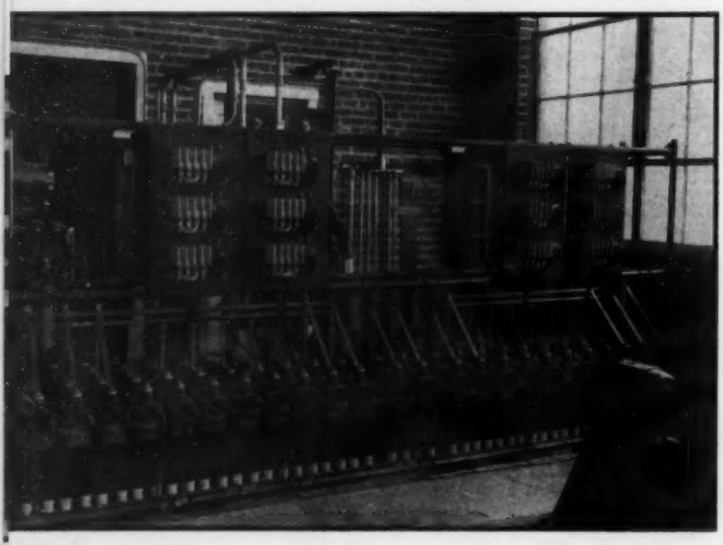


Figure 14 — Oscillator of 100 kw capacity, showing rectifier, tank circuit and oscillator tube.

▲

Figure 15 — Assembly of capacitors for melting furnace.



There are two major problems: (1) One is the large amount of heat to be transferred from the working dielectric to the water cooling coils; (2) the large high frequency currents generally required. The short time "load on" characteristics of many induction heating applications makes it desirable to have multi-tap units so that the capacitance values can be preset, and varied to suit the application. When capacitors are used for melting furnaces, a number of contactors are connected so as to vary the capacitance as the heat progresses.

PROCESS

Induction heating has been successfully applied in a great many different heat treating processes. Some of these operations which are done inductively cannot be successfully duplicated by other methods of heating, others are justified by special advantages such as freedom from scale and distortion; others again are adopted in preference to alternative methods for reasons of production, since it is well known that the inductive method is unrivalled in the speed at which the temperature desired in the piece can be obtained.

Melting furnaces — Over 200,000 kw in motor generator sets for induction heating applications have been installed up to the present. Of this total, approximately 30 per cent supplies melting furnaces of various sizes, another 30 per cent is for surface hardening and the rest is in other miscellaneous heating jobs.

The coreless induction melting furnace was the earliest commercial application of induction heating, and has grown steadily since its introduction by

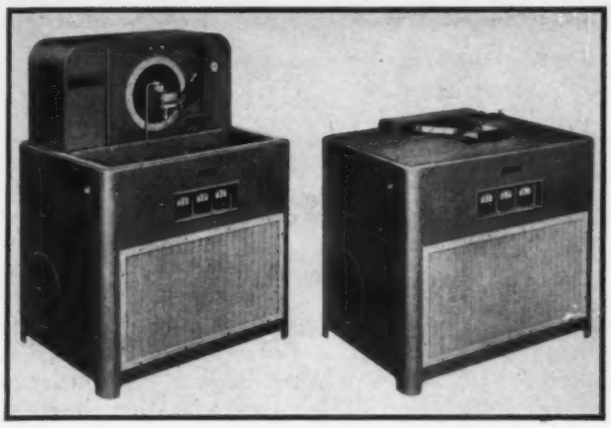


Figure 16 — Induction heat treating cabinets for surface hardening and similar applications. ↑

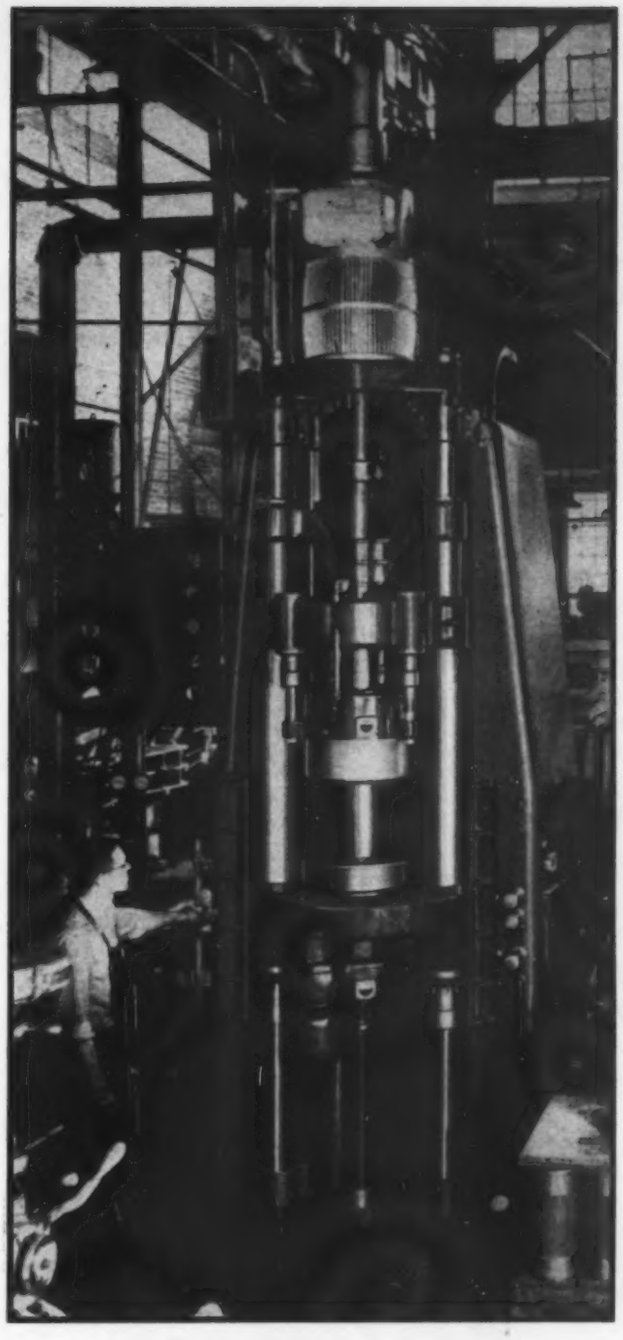


Figure 17 — Induction unit for hardening the internal bores of hollow pieces. →

Dr. Northrup in 1916. It has many advantages when special alloy steels have to be made with exacting specifications, it is speedy and has an inherent stirring action due to electro-magnetic forces in the charge which is very desirable. The disadvantages are its relatively small size from a production standpoint, and the expensive power supply required for it.

Surface hardening — This process is definitely in the class in which induction heating is the outstanding method. It far surpasses other hardening methods in speed, freedom from scale and warping, and is used in so many applications that a complete article would be necessary to cover them. One important advantage is the complete coordination of the power supply including capacitor, heating and timing units and the quenching devices.

Internal diameter hardening — Many intricate machines have been built for this purpose, and internal diameters are hardened as well as external surfaces. A few of the applications may be mentioned: automotive wheel hubs, propellor hubs, gears large and small, cylinder liners for diesel engines, etc.

Welding, forging and upsetting — Applications of this type fall in the class of operations for which other methods can be used but induction heating is preferred because of the advantages it offers. Some of these advantages are, high production due to fast heating cycle; uniformity of temperature distribution, resulting in high quality; soft scale which does not shorten the life of the punches and dies, better working conditions around the heating unit, and comparatively small floor space required.

Induction brazing and soldering — This is a field for induction heating which has only recently been developed. There are so many possible applications of this type that it would be difficult to cover them all. In general the inductor coil used will conform to the shape of the part to be heated. Frequency will depend on the geometry of the parts and on the materials being brazed. Temperatures will also depend on the soldering or brazing alloy used. Silver soldering is done in the range from 1175 F to 1600 F depending on the silver alloy used. Copper brazing is done at temperatures from 1300 F to 2050 F which is required when pure copper is used for the brazing material. The chief advantage that induction heating has over other methods for this operation is that heating is fast, making atmosphere unnecessary, it can be closely controlled, and can be confined to a narrow area where it is required.

Miscellaneous applications — Many miscellaneous ferrous heating jobs can be done at normal 60 cycle frequency. These are cases where the diameters used are relatively large, and the temperatures do not

exceed the Curie point. The heating of autoclaves and large chemical vats for example. In installations of this kind the coil is simply wound around the vessel with suitable insulation.

Other applications using 60 cycle are the expansion heating of rings, liners, casings, etc., operations such as placing tires on railroad car wheels, or lining guns are readily accomplished. Many other specialized applications can be made where dimensions and the temperature required permit the use of 60 cycle energy.

Tin reflowing — In all the history of induction heating no new application has met with such rapid and widespread adoption as the inductive method of reflowing tin on electrolytic tinning lines. Starting with a relatively small 100 kw pilot line installation, within a few months equipments for this application actually installed total about 10,000 kw of 200,000 cycle power requiring nearly twice that much 60 cycle energy.

Tinplate produced by an electrolytic tinning line has a gray matte surface. The smooth polished surface with which we are familiar can be obtained by heating the surface of the tin so that it flows, and then quickly cooling it. The reflowing as it is called not only brightens the surface, but reduces the porosity of the coating, and thus improves its corrosion resistance.

Several methods have been used for this operation:

1. Passing the tinned strip through a hot oil bath.
2. Passing the strip through a radiant tube or some other type of furnace.
3. Heating the strip conductively by passing current through it.
4. Passing the strip through a high frequency inductor heating coil.

Since the melting point of tin is low (450 F) and the differential between this temperature and the safe temperature for the oil is low, speed of the line is limited for the hot oil scheme. Radiant heat furnaces also require a great deal of space so that speed is again limited and both methods require that the speed be constant because the large storage of thermal energy prevents the change in speed. In addition to this neither operation lends itself to incorporation in the tinning line itself, so that handling of the strip is increased.

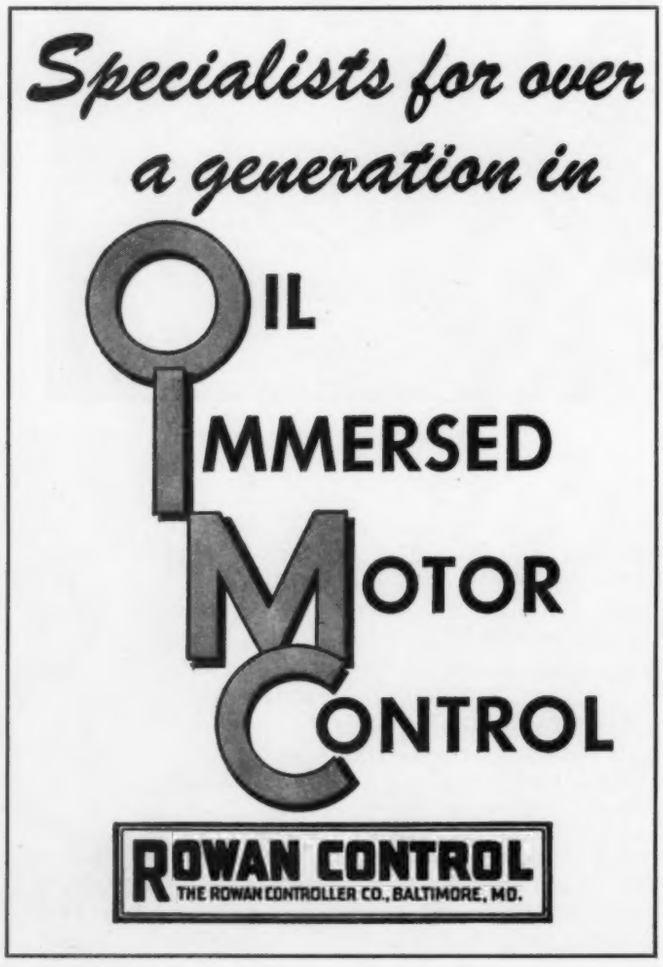
The conductive method of heating the strip does not have these limitations but presents problems of getting power into the strip at high speed without arcing or burning at the contact rolls; also the contact with the strip introduces the possibility of marring the surface.

The induction method requires no contact with the moving strip, and because of the low temperature, is ideal for this particular application. The speed up to 1000 fpm of commercial tinning lines is fast, so that applications require large power, and because the thickness is small a high frequency of 200,000 cycles has been found quite satisfactory.

The speed of heating is quite phenomenal, within .7 of a second after the strip enters the coil the temperature is brought up to 450 F where the tin melts and starts to flow into a smooth even surface. The coil required is not long and it is possible to put 600 kw of energy into the strip in a space only 6 feet long.

CONCLUSION

This brief picture of induction heating methods and equipment is far from complete. It is difficult in a single article to cover all of the applications. Some are still in the developmental stage, others are not so important commercially. There is no doubt that induction heating has made rapid strides, particularly as a mass production machine tool. New uses for this tool are being discovered and it appears certain that further development in the electrical equipment and the heating units will be made in the future. As we gain more experience with the higher frequency power supply such as oscillators and spark converters, applications which are now thought impractical will be worked out. More important than this, fundamental research will remove some of the present limitations in inductive heating. The distinct advantages in this method will operate to broaden its field of use. There can be no doubt that induction heating will progress just as much after the war, as it has since war time demands brought it squarely to the front.



THE *Merchant Mills* AT GREAT LAKES STEEL CORPORATION

by Charles Moon and Thomas Smith

SUPERINTENDENT OF MERCHANT MILLS — ROLL DESIGNER

GREAT LAKES STEEL CORPORATION

ECORSE, MICHIGAN

The Mills

by Charles Moon

▲ AT Great Lakes Steel Corporation, there are two merchant mills: a 10 in. and a 14 in. The 10 in. mill has an unusual range. It will roll from 3/8 in. rounds and squares to 1 11/32 in. rounds or squares, small flats from ¾ in. x 5/32 in. to 4 in. x 7/16 in., and also quite a few of the smaller special sections. The size of the billets used are 2½ in., 3 in., 2½ in. x 4 in. and 2½ in. x 4½ in. Billets from 25 to 30 feet long are used.

On the 14 in. mill, the billet size is 2½ in., 3 in., 4 in., 6 in., 7 in., and 7½ in. x 8½ in. and various sizes of slabs from 2½ in. x 4 in. up to 2½ in. x 14 in. All billets are 25 to 30 feet long, except the heavier blooms, which are 15 ft long.

The sizes rolled on the 14 in. mill are from 1 in. rounds or squares to 4½ in. rounds or squares, and flats from 1½ in. x ¼ in. to 13½ in. by various thicknesses. Besides, there are rolled an assortment of special sections such as T-bar for brake bands, auto bumper sections, auto rim sections, turret ring sections for tanks, and many other sections. Especially significant is the fact that one length of turret ring section weighs about seven hundred and forty pounds.

When the schedule man receives his order, it has complete data including size, chemistry, metallurgy, surface requirements, tolerances, and shipping instructions. Many orders come through which call for a dead length, which means that a lot of good steel is unnecessarily scrapped. Wherever possible, it is important that a multiple length should be given.

It is up to the schedule man to build up an inventory of heats of different specifications. Heats will have to be rolled on the blooming or bar mill into various size billets. This means about forty different analyses to provide, so quite an inventory of billets is kept in order to keep the merchant mills running. When a certain size is being rolled, we like to roll all the orders of one size, regardless of chemistry.

Before rolling the steel on the merchant mills, all the billets and blooms must be processed to get rid of surface defects, principally scabs and seams. To do this, billets and blooms are pickled and then scarfed or chipped. For the more particular types, they are bloomed, cleaned and rerolled and re-chipped.

When charging in reheating furnaces, each bar is

checked to make sure there has been no mix-up while they were going through the various cleaning operations. There are a great many types of steel which require furnace control to keep the decarburization to a minimum. Others require a very high degree of heat. A constant check of heating by the combustion and metallurgical departments is required for this.

The furnaces on the 10 in. and 14 in. mills are of the end charged, continuous type. They will take up to thirty foot billets. Ejection from the furnace is directly onto roll tables with a hot shear within 4 ft of the point of ejection.

At Great Lakes the 14 in. merchant mill consists of fourteen stands of rolls with vertical rolls preceding No. 1 stand and No. 5 stand. These vertical rolls are the edging rolls for the continuous strip. It is unique to have a merchant mill rolling hot strip and merchant bar.

The 14 in. merchant mill at Great Lakes consists of 14 stands and produces a great variety of products (including strip) from a wide range of billet sizes.

▲

The 14 in. mill has three separate outlets (from stands No. 9, 12 and 14). Cooling beds are provided in the outlets from No. 12 and 14 stands. No. 9 stand, which is the finisher for strip, is followed by a flying shear.

On this mill, there are three separate finishing stands, No. 9, No. 12, and No. 14. There are cooling beds from No. 12 and No. 14 stands. No. 9 is the finishing stand for continuous strip. After No. 9 a flying shear is provided, with its speed synchronized with the roll speed.

A short motorized run-out table provides space to carry the sheared lengths of strip to an annealing bar piler. This space is equipped with water spray to give the physical properties required by the metallurgy department.

To finish wide flats of heavier thickness, the No. 12 stand is used. It also takes from 2½ in. to 4½ in. rounds and squares. Bars requiring sawed ends are finished from this stand, being carried on a run-out table to the hot saw. The saw is provided with two short cooling beds with a cradle arrangement from which bars are removed by a spider with the second crane. Bars from this stand not requiring sawed ends continue to a larger cooling bed, from which they are transferred to the first mill shear. The same shear approach table is used to carry the product finished from No. 12 stand and from No. 14 stand. Excess tonnage which cannot be taken by the first shear is transferred to an auxiliary shear. When not in use for the mill production, the auxiliary shear may be used for re-shearing from the warehouse.

No. 14 stand is the finishing stand for rounds and squares from 1 in. to 2½ in., flats from 1¾ in. to 6 in. and various sizes of special sections.

On flat sizes such as spring steel, which require pack annealing, the cooling bed from the No. 14 stand is used. This bed is of such sturdiness that its entire length and breadth, or any part of it, can be utilized for pack annealing.

Thus, the first 8 stands of this mill constitute the roughing unit. A bar coming from No. 8 stand may be carried to No. 9 and No. 10, and thence by the runout table back to No. 11 or may be transferred directly across from No. 8 to No. 11 stand. Thus No. 9 and No. 10 stands become intermediate roughing stands for bars finished in No. 12 or No. 14 stand, or when reduction requirements permit, they may remain idle. From No. 8 stand on, all bars may be handled by transfer tables, or when size permits, may be looped by hand from No. 8 to No. 11 to No. 12 to No. 13 to No. 14.

This arrangement gives this mill great flexibility, saving many roll changes. A concrete example of this is when using a 6 in. x 6 in. billet. This bar is reduced to a 3 in. square by using the first six roll stands. No. 7 and No. 8 are idle. This bar may continue then to No. 9 and No. 10 and then back to No. 11 and No. 12, finishing a 2 5/8 in. round.

Taking the same 3 in. square from the roughing it may be transferred directly to No. 11, 12, 13, and 14 stands, finishing a 2¼ in round in No. 14 stand.

When finishing in No. 14 stand and not using No. 9 and No. 10, these stands may be changed for some other size while mill is in operation. Likewise when No. 13 and No. 14 stands are not used they may be changed for future use while mill is in operation.

Summed up, this mill with careful scheduling, roll designing and rolling, adds up to a flexible installation.

Roll Designing

by Thomas Smith

▲ UNTIL the end of the 19th century designing of rolls was attended by considerable mystery. Roll pass design was considered to be a secret art, carried out behind closed doors and passed along from one roll designer to another, or from father to son.

There are a few text books on roll designing but they are of little practical value, as each roll designer must produce the required section on an existing mill, of which there is a large variety.

In designing rolls for merchant mills, or in fact any mill, the designer must know the limitations of his mill, so that he will not attempt to make a section that is too large for his mill or too small to be worth while on a large mill. Merchant mills are operated for the sole purpose of producing sections to customers' orders and hence the designing of passes is to produce sections as nearly as possible to customers' specifications.

The first step for a new section is of course an inquiry through the sales department. This is forwarded to the roll designer with a sketch or drawing showing required tolerances, finish and quantity required. The designer estimates the number of passes required which determines the original cost of equipment; he then forwards this to the sales department who decides whether there is enough tonnage in sight to warrant the expense. Sometimes as in case of war products, expense is disregarded and rolls are made up to produce very small quantities. When a new section is approved we lay the section out to scale allowing .012 in. per inch for shrinkage which is the amount we have found from experience is required on our mills. Some mills require more and some less, depending on the grade of steel and the finishing temperature, which on our mills is approximately 1800 F. We then locate the pitch line which is from 1/32 in. to 1/16 in. above an imaginary line running through the center of the section as it is delivered from the rolls. This locating of the pitch line is very important, because if it is not located correctly the section will try to follow the smallest roll and may go up in the air, endangering the workmen, or down against the bottom guide too heavily, breaking the guide and causing a wreck. By raising the pitch line slightly we try to make the top roll from 1/32 in. to 1/8 in. larger than the bottom roll which causes the bar to ride the bottom guide lightly and deliver better from the mill. There are several methods of locating pitch lines.

We then pin the finishing pass down and lay a piece of transparent paper over it, then superimpose the leader over the finisher, taking care to keep as nearly as possible the same percentage of work at each point. This is important, as in sections (such as channels), if there is too much work on the web, the flanges will be pulled down and be short, or the web may be ruptured. The forming passes are laid out in the same manner, but the further back we get into the roughing passes, the less becomes the need to hold the percentage of reduction so accurately.

Sections are made by bending, squeezing, or spreading the steel, and the designer may use any or all of these methods in a section, depending on the layout of his mill and the shape of the section.

We usually pull a light draft in the finishing pass and leader, and use harder rolls. This gives us a longer life and better finish. We increase the draft from there on back to the first forming pass and use stronger rolls, so that the designer has to decide whether to use chill, grain, steel or alloy steel rolls. Chill and grain rolls are much harder than the steel or alloy steel and give a much longer life, but they are more brittle and the designer must know the various types of rolls.

Each section presents a problem of its own and there is no set rule whereby the designer can lay out his passes, as what works on one mill may not work on another due to the different mill layout, the different size of the rolls, the human element, etc. The designer must work closely with the rollers. Even on such simple sections as rounds and squares there are different methods of forming, and which is the best is largely a matter of opinion. On rounds some mills use the diamond, square, oval, and round method. We use the flat, edge, oval, and round system and it has worked very successfully for us.

Sections may require anywhere from one to twenty shape passes depending on how complicated they may be. Each section must be balanced correctly in the different passes or it will pull sidewise and may rob the edges. This is the first difficulty to overcome on any new section. After we have the section riding level through the mill it may be necessary to fill in a few empty spots. We always try to work on the safe side; that is, we would rather have an underfill than an overfill, as it is much easier to open up one of the preceding passes so as to fill the vacant spot than to close in a pass which often necessitates either cutting the whole roll down to scrap size or turning a new roll.

We try to keep away from sharp corners on any section, as they are difficult to produce without an overfill, and if the sharp corner is on the inside of the section a sharp corner is required on the roll, which will burn off in a short time and necessitate frequent changing of passes, cutting down the tonnage per pass and increasing the cost. I have found that most sharp corners are not really necessary, and the customer will often agree to a radius if it is called to their attention.

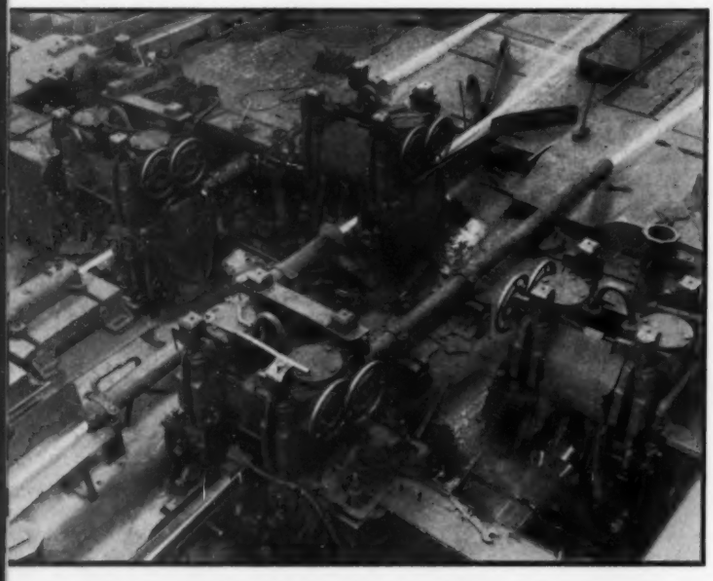
We also try to make sections as nearly symmetrical as possible to keep away from warpage in cooling, and in a great number of cases we can produce a section double, splitting it afterwards either at our plant or at the customer's.

The speeds of the various stands are important in

rolling sections, as on mills where there are individual variable speed drives on each stand the designer has more leeway in the reduction made in each pass. Where the speed of each stand is fixed, the reduction in each pass is fixed or a buckle or a pull will result, causing the section to be very uneven.

Two roll designers, given the same section to make, will very seldom develop the design in the same way. This is mostly due to the fact that they have a different mill layout on which to produce the section and they will try to use standard size billets which may be different in each plant, and they also have different men doing the rolling.

I am often asked, "How much tonnage is a pass good for?" It is not the weight rolled that wears the pass, but the number of feet of steel that goes through the pass. If a pass for 1 in. rounds is good for 100 tons, a pass for 2 in. rounds should be good for 400 tons, as there is the same number of feet but the weight is four times as great.



The Great Lakes 10 in. merchant mill can produce rounds of $\frac{3}{8}$-$1\frac{1}{32}$ in. diameter and flats $\frac{3}{4}$-4 in. wide, as well as various small shapes.

▲

Runout and cooling bed in 10 in. merchant mill. The roll storage indicates the great number of rolls required in merchant mill operation.

We figure spread as equal to 33 per cent of the draft in most cases, but in heavy drafts the spread can be anything. I have seen 70 per cent spread where we pulled a $1\frac{13}{16}$ in. square down to $\frac{9}{16}$ in. flat in two passes, and $\frac{1}{2}$ in. square pulled down to $\frac{1}{16}$ in. thick in four passes spread out to $1\frac{1}{4}$ in. wide. Large diameter rolls will spread the steel more than small diameter, and cold steel will spread more than hot steel; also, there is a difference in spread due to the alloy content of the bar. Small bars will spread more than large bars. We try to allow enough clearance between the rolls, so that the rollers can take care of the difference in spread by raising or lowering the rolls.

There is a great variety of passes to choose from, and the designer must decide what type to use, depending on the shape of the section and the mill layout on which it must be rolled. Open and box passes are generally used on blooming mills and billet mills where the reductions are not heavy. They are not so good for heavy reductions as the steel will spread out into the openings between the rolls and may cause laps or fins. Breakdown ovals are the best for heavy reductions but they do not help the quality of the product. Diamonds and squares will not reduce as much as ovals but they work all sides of the bar and in my opinion give a much superior quality. Tongue and groove passes are mostly used for special shapes and spread can be pretty well controlled in this type pass by fillets in the corners that come opposite the opening in the next pass.

Our No. 1 merchant mill (14 in.) covers a large range of sizes. We can roll from 1 in. to $4\frac{1}{2}$ in. rounds or squares and flats from $1\frac{1}{2}$ in. to $13\frac{1}{2}$ in. wide (depending on the edge and thickness required), as well as various shapes.

No. 2 merchant mill (10 in.) can produce from 3/8 in. to $1\frac{11}{32}$ in. rounds and flats from $\frac{3}{4}$ in. to 4 in. wide, as well as various shapes.

Blooming mill rolls are usually turned with the bottom roll slightly larger than the top to take advantage of the difference in peripherial speed which causes the bar to try to follow the top roll and helps to keep the ends of blooms and slabs from gouging into the table rollers. The bar mill rolls are turned with the top roll 1/8 in. larger than the bottom to make the bar ride the bottom guide which is more solidly held than the top guide. On the hot strip and cold strip mills we keep the work roll diameters as closely as possible the same, allowing only .003 in. on the cold mill and .010 in. on the hot mill.

We turn and grind rolls for strip mills with a slight crown in the center; that is, the roll is larger in the center of the body than on the ends. This is done to compensate for the bend of the rolls in the mill when the bar enters the different passes. There is no way to figure these crowns and it is only a matter of cut and try until we find the required crown. Rolls for the old style sheet mills are turned concave, that is, smaller in the center than the ends, so that after they are warmed up (which usually takes the first turn each week) they will produce a flat sheet. There are several tricks used to keep the sheet rolls from getting excessively hot, such as keeping steam blowing on the

bodies or keeping water running on the necks to help dissipate the heat.

The different finishes on hot and cold strip mill rolls are obtained by using different size grain in grinding wheels. To get a so-called mirror finish we start with a coarse grain (about 36), rough the roll down close to size with this, then change to a 120 grain for semi-finish and finish the roll with a 320 grain, or where a better finish is required we then put on a 500 grain wheel. For some types of work, such as for rolling aluminum, they may use a wheel as fine as 800 grain.

Rolls are turned in a special lathe on neck chucks which give them the same action as when they are in the mill. If they were turned on centers, as shafting is turned, they would run out of round in the mill due to the wear of the lathe centers and the center hole in the roll.

The roll turner is a highly skilled mechanic who through years of experience develops an unbelievable feel with the calipers. I have seen roll turners point out what they call high spots that by actual measurement were only one-half thousandth of an inch larger than the balance of the roll. Also, in fitting templets an experienced roll turner can work until you cannot see light past the sides and you can see light through a one-half thousandth opening. This is done by the correct grinding of tools, in which the experienced roll turner becomes very proficient. This is a job that can only be learned by actually doing it and by continual practice.

Roll makers have made great progress in the manufacturing of rolls in the past few years. Twelve years ago, if we had a pass that produced 50 or 60 billets it was considered a fairly good roll; now we can run from 150 to 200 billets per pass. These billets are cut into four pieces at the furnace and each piece finishes about 90 feet long. The same progress has been made in rolls for hot strip mills. When we first started our No. 2 hot strip mill, four hours was about the limit for a pair of rolls. Now we get from 8 to 12 hours on strip for the cold mill which requires a very good finish. On plate we get from 24 to 48 hours rolling per set.

DISCUSSION

PRESENTED BY

J. C. PATTON, JR., Sales Representative, Heppenstall Company, Detroit, Michigan.

THOMAS SMITH, Roll Designer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

W. J. EVANS, Rotary Electric Steel Company, Detroit, Michigan.

D. J. ROSECRANS, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

C. E. S. EDDIE, Plant Lubrication Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

H. C. HOEFT, Electrical Designer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

W. H. CLARK, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

R. E. WALSH, Continental Foundry and Machine Company, East Chicago, Indiana.

J. A. CLAUSS, Vice President in charge of Engineering, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

JOHN SOLOMON, General Foreman, Roll Merchant Mills, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan.

J. C. Patton, Jr.: I would like to ask Mr. Smith if he has developed any particular method of arriving at tons rolled or number of feet rolled on strip.

Thomas Smith: Some places keep tonnage on rolls, but we do not. As I see it, if you roll 100 tons of No. 16 gauge on a pair of rolls, and 1000 tons of $\frac{1}{8}$ inch thickness, you have done more damage rolling the 100 tons than you did rolling the 1000 tons. So I do not think tonnage is fair to any roll. We only keep track of the reductions and the number of times in the mill.

You might have a run of heavy gauge — we will say $\frac{3}{16}$ or $\frac{1}{4}$ in. thick for eight or ten hours and not do as much damage or wear those rolls as much as one hour on $\frac{1}{16}$ in. thick.

J. C. Patton, Jr.: I would think it would be a very difficult proposition, but I understood some people were trying to correlate gauge and stand position to arrive at a foot-tons figure for roll life.

Thomas Smith: I know some people do, but we figure it is not fair to any rolls to charge them up with so much tonnage if they went in and had a lot of light gauges, whereas the next rolls might go in on a big turn of heavy gauge.

L. R. Milburn: What shape do your rolls come in when you buy them from the manufacturer?

Thomas Smith: Some plants buy rolls in the rough and do their own necking. We have done very little necking. At our plant we buy rolls with the necks already finished and bodies in the rough. From there on, we finish them up.

L. R. Milburn: What about your shape rolls?

Thomas Smith: We also buy them with the necks finished and bodies in the rough. We start right in on the rough body and cut that for required shape. Some places have them rough turned, and other places have necking lathes and do their own necking.

W. J. Evans: What about shadows on bars?

Thomas Smith: There are a lot of different kinds of shadows and they come from a lot of different reasons. For instance, if you have shadows running straight across the bar, or even with a slight curve on them, they might come from roll ragging any place

between the ingot and the finished bar. They can also come from a worn tooth where the pinion teeth are not meshing properly. They can also come from a vibrating spindle somewhere along the way, or from too much draft in finishing, causing a ripple as it comes out of the mill, mostly on light gauges. It also can be caused by trying to get too much life out of the roll, for which the rollers blame me. Another kind of shadow you may get is a sort of blotch over the bar. Those can come from deep furnace scale. The hydraulic sprays clean the scale out and leave a pit which the rolls smooth out, but you can still see shadows along the bar in blotches. You can't measure them. There is no depth, but you can see them.

There is also another kind of shadow which you may get on a section which might be thinner in the center than on the edges. That is an elongation shadow caused by stretching the middle of the bar out longer than the edges.

W. J. Evans: Do you get any shadows from a sharp oval, for instance, going into a round pass?

Thomas Smith: You might.

W. J. Evans: If you get an oval too blunt, will it cause shadow lines at the break?

Thomas Smith: If you get an oval going into a square, and that oval is blunt, you can get all kinds of shadows. What you have to do is fill the oval up a little more. If you get it too sharp on the end, you are liable to get a lap.

W. J. Evans: Which do you prefer, a sharp oval or a blunt oval?

Thomas Smith: I don't like ovals at all. Ovals don't help quality. If you have a square going into an oval, and the steel has been heavily chipped or scarfed, we come along with an oval and squeeze those scarfing cuts shut, and you have seams in your bar. You might not be able to see them, but they are buried in there, and when you turn the bar up into the square, they carry right into the corner, and then carry right through the mill.

Therefore I don't like ovals, but once in a while we have to use them to get necessary reductions.

D. J. Rosecrans: Do you think billet heating would have anything to do with that?

Thomas Smith: Well, if the billet isn't as hot as it should be, it will spread more, and is liable to go out into the parting between the rolls. A cold bar will spread more than a hot bar. I would say heating could have something to do with your trouble.

L. R. Milburn: You stated you made allowance for shrinkage of your steel. Do you also make allowance in your design for increasing of the roll size due to heat?

Thomas Smith: No. The rollers take care of that in the screwdown, but when you have water running on the rolls, any increase is so very slight it is not noticeable.

C. E. S. Eddie: I want to ask a question on necking. You have water cooled composition bearings on the roll necks on our No. 1 bloomer. What does this mean in the maintenance picture? Is it going to be an economic advantage?

Thomas Smith: If they don't take proper care of necks and bearings in the mill, it will score the necks, and we will have to polish them as best we can in the shop.

C. E. S. Eddie: Isn't it true that if the maintenance department gives adequate protection and care for the roll neck bearings it will do away with fire cracking, thrust wear, etc.

Thomas Smith: If they give them proper care in the mill and don't let the scale in and keep adequate water on them, they should not have any fire cracking on any bearing.

H. C. Hoeft: After a diamond is used a certain length of time, would it be profitable to turn the roll for a square?

Thomas Smith: Yes, you could turn it for a larger square, but you couldn't make a diamond into a smaller square unless you cut it way down. But you can use the rolls by making them for larger sizes.

W. H. Clark: What about roll reduction?

Thomas Smith: I try to get 1½ inches of life out of our merchant mill rolls. Sometimes we can get it. Sometimes we can't.

If we go too far on flat rolls and try to roll light gauge on them, the bar will come out with a riffle on it and shadows result. In that case, all we can do is save those small rolls for heavier gauge, where the riffle doesn't show up.

If you get the diameter of your roll too much below the pitch of your mill, you are going to get into trouble. We try to start out ¾ in. above the mill pitch and go down to ¾ in. below. That gives us 1½ inches of life. Something may interfere and we can't always get that.

On the 14 in. merchant mill, we have roller bearings, and due to the bearing boxes coming together, we only get 1⅜ inches.

We try to base the life on the condition we have in our mill. In some mills we can get 1¼ in., in others 1⅜ in., and in others 1½ in. If we get 1½ inches, we consider we are getting a fairly good life out of our roll. On some roughing rolls we get as much as 3 in. and on the blooming mills 5 or 6 in.

R. E. Walsh: I think it would be of interest to show how you dress rolls and bring them to life again after rolling 150 to 200 tons.

Thomas Smith: That depends on the shape of our pass. We take the rolls back to the shop and put a templet in the passes and see how much they are worn, first. The roll turner picks out the worst worn pass and takes a cut until that pass is cleaned up, and the rest of them should clean up.

On a round pass, we take a round nosed tool and sink it into the bottom until we have it all nice and clean, and then take a round plug and put it in the pass to true it up. We scrape all the rust off first, because rust will take the edge off the plug, which is made out of carbon tool steel.

Member: Isn't it true, with the diamond and square breakdown you would have more rolled-in scale than you would with box pass?

Thomas Smith: Yes, but you can't pull as much draft with a box pass. If you had a box pass and you would pull the same amount of draft as you would on a diamond, you would get a fin out here at the side.

It is much the same as with the oval. You can pull a heavier draft with an oval, but if there are any defects in the side of it, you bury them right in the steel.

L. R. Milburn: On the merchant mill, you design

the roll so you can get several different passes in the same roll, don't you?

Thomas Smith: Yes, we use up the full length of the roll. The rollers tell me I'm too greedy. I try to get out too close to the end. There never was a roll made long enough to get all the passes you would like to get in.

L. R. Milburn: What happens then?

Thomas Smith: You get trouble with your guide fixtures. You are just too close to the end. Also, on our mill the tables are narrower than the roll, so the closest you can get is 7 inches from the end of the roll to the center of the pass.

J. A. Clauss: I am glad to be back in civilization again. It has been a great many years since I had to figure roll passes, but I had the good fortune to go through the industry about a year ago for about eight weeks, and the thing that impressed me more than anything else was that the old three-high mill was doing a good job.

In one particular mill they had a three-high roll stand ahead of the continuous roughing stands, in which they could give the billet one, three or five passes before it entered the continuous roughing mills. This cut down the number of billet sizes they had to carry, because they could reduce the billet in the three-high stand to suit the continuous roughing mill. We have to carry a number of billet sizes and change the roughing mill rolls frequently to cover the wide range of sections we roll.

It might be of interest to elaborate a little bit on the reductions and speeds. Where you have individually driven stands, it isn't quite so difficult as where you have a continuous mill with one drive. I think that it would be interesting to elaborate on the fact that you have a constant volume of metal from stand to stand, and, if you have a heavy reduction, you have got to slow up on speed. Your speed and reduction have got to go hand in hand, because the volume of steel passing has always got to be constant.

Thomas Smith: In my paper I said that where we had variable speed motors with individual drives we did not have to worry so much about that, whereas on continuous mills where the speeds are fixed you have to have the same amount of steel flowing through each pass. We use a constant equal to the area of the pass times the rpm times the rolling diameter of the roll. That constant has to be the same in every stand when you have a continuous mill. If you don't have the same amount, you will get a pull or a buckle and possibly a cobble. So the question is what to use as the rolling diameter. On the diameter of the rolls, there are different ways of taking the rolling diameter. On a diamond, most people use 66 per cent of the depth. On a flat bar you use the bottom of the groove as your rolling diameter. On a flat roll you use the face. On a 90 degree square you take 50 per cent of the depth. On diamond passes this percentage varies with the angle of the diamond. As the angle of the diamond goes up, we take the rolling point farther down, in proportion to the angle, until we reach the bottom, which would be a flat again; we use a direct proportion: 50 per cent of the depth is to 90 degrees as the point of the rolling diameter is to the angle of the diamond. On a 120 degree diamond, the rolling diameter would be 50:90 — RD: 120, or 66.6 per cent of the depth of the groove.

J. A. Clauss: When I was designing roll passes for a certain merchant mill some years ago, this question of mean diameter for a diamond came up. We put a mark in one side of the groove in a roll and rolled a number of bars. We then carefully measured the distance from mark to mark, with due allowance for shrinkage due to temperature. Since the distance between marks represented the circumference, the diameter was determined by dividing this length in inches by 3.1416. This gave us the mean diameter for a diamond pass one-third up from the bottom of the pass or two-thirds down from the centerline between the rolls.

John Solomon: How about the diameters from one set of rolls to another?

Thomas Smith: You still have to come back to the constant. If you adjust one set of rolls in a continuous mill, you have got to adjust them all.

John Solomon: What is the percentage of variation you would allow on the constant?

Thomas Smith: Some roll designers go as much as 5 per cent. I usually try to stay closer than that. I try to give the roller the benefit and keep it within 3 per cent, if I can possibly do so. That gives the roller a little leeway to adjust his rolls.

John Solomon: Where do you have the most roll breakage, on the neck or the body of the roll?

Thomas Smith: On our merchant mills, due to roller bearings and small necks, we have more breakage on the necks of the rolls. On No. 1 and 2 strip mills we have the most trouble on the ends. Most of the breakage is wobblers twisted off the rolls.

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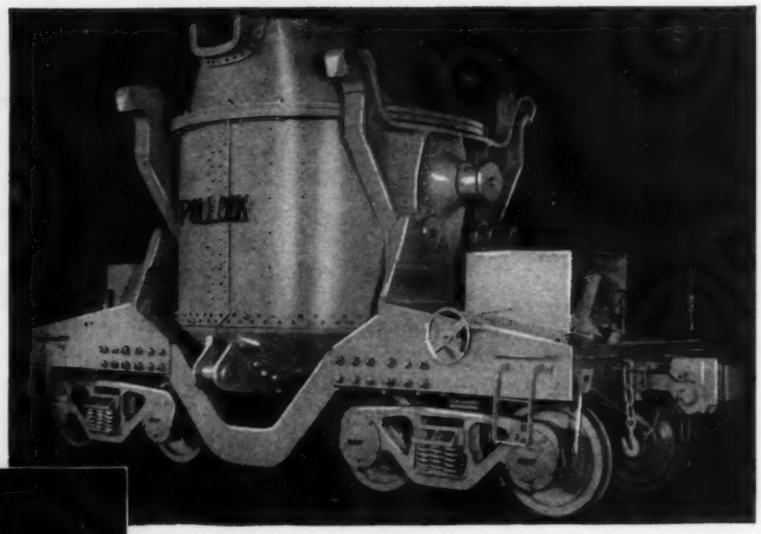

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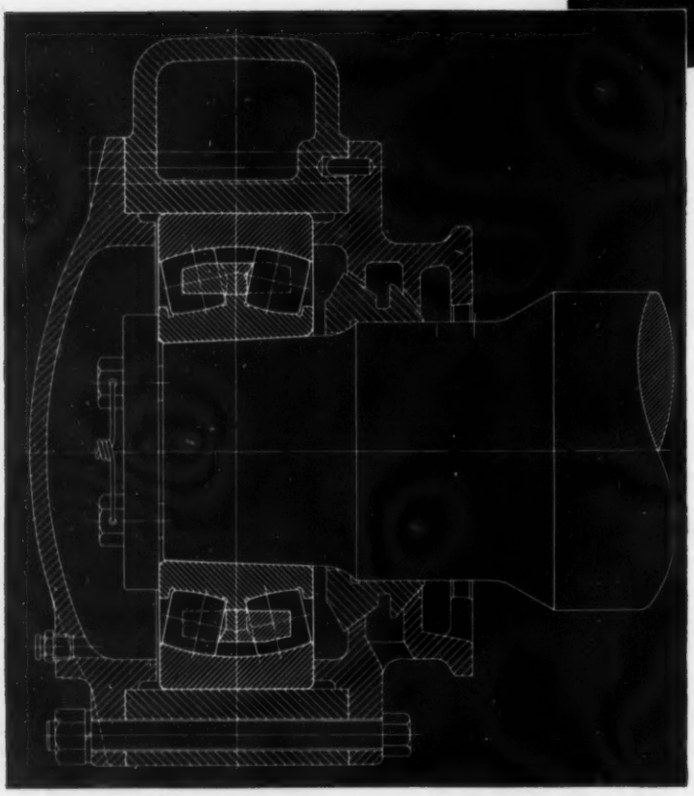

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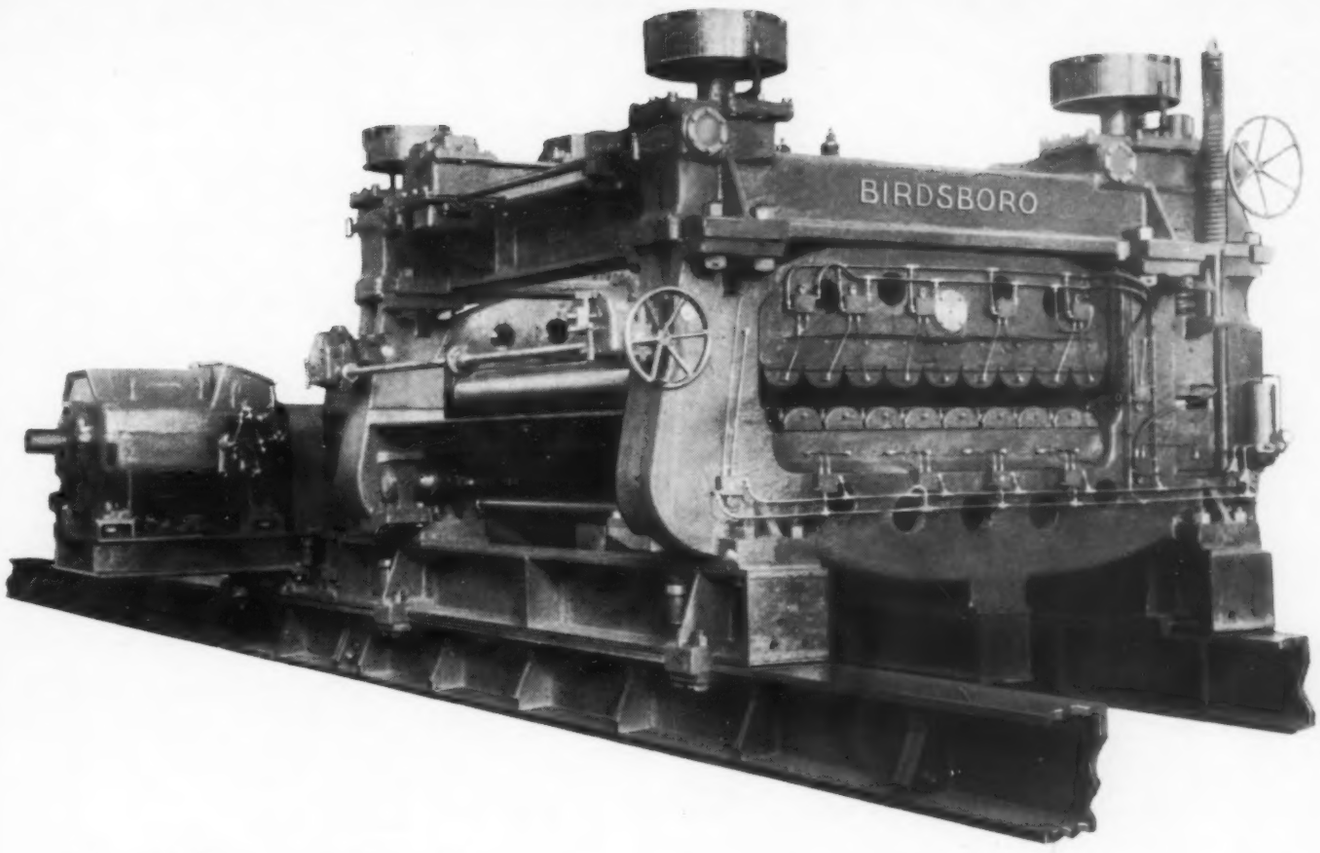

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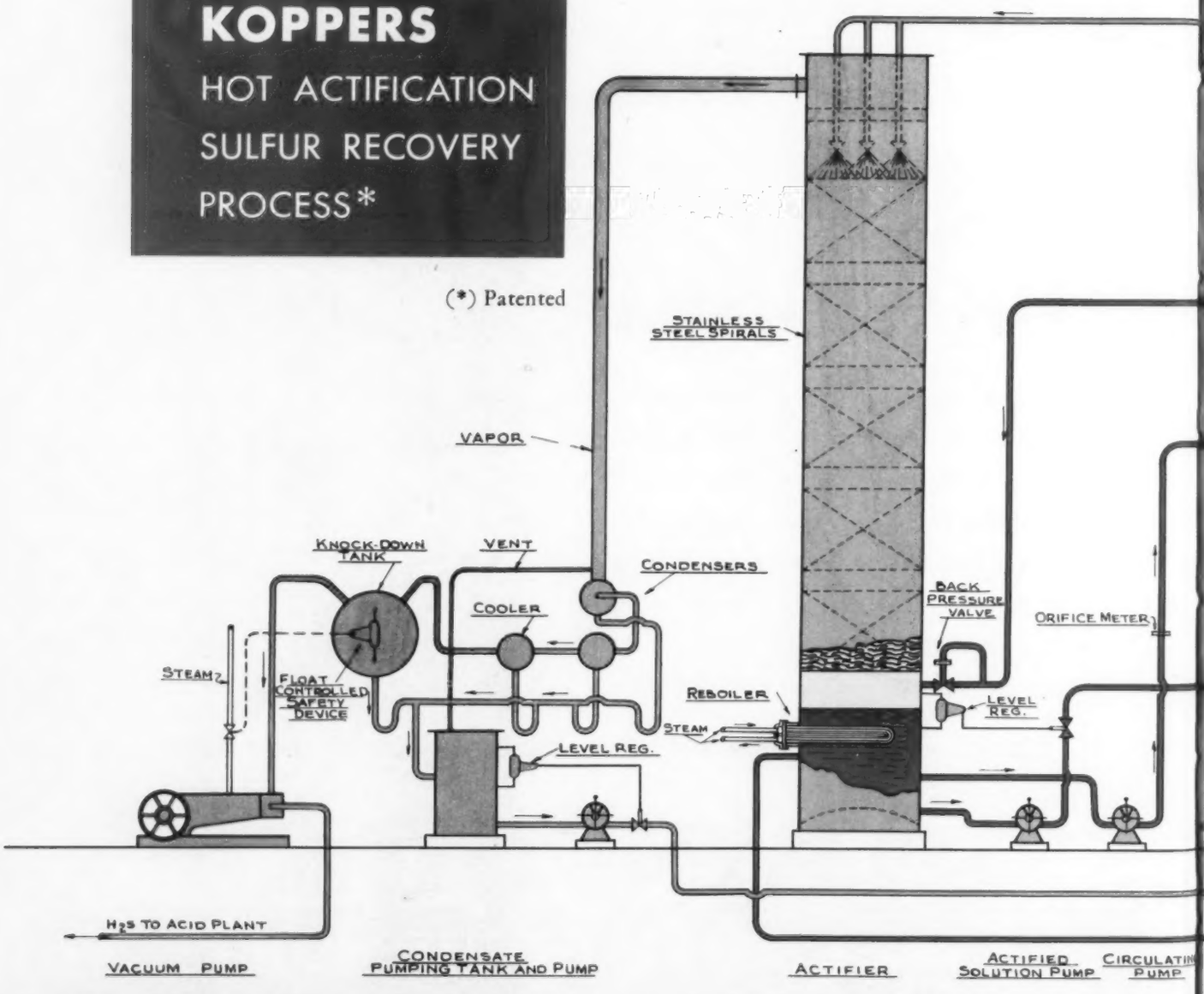

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Most steel mill coke plants have sufficient hydrogen sulfide in coke-oven gas to meet all of their requirements for sulfuric acid for ammonium sulfate production and light-oil washing. Often the H_2S concentration is high enough to provide acid for the pickling plant as well.

This hydrogen sulfide can be recovered at low cost by the Koppers Hot Actification Sulfur Recovery Process * in a form readily convertible into sulfuric acid by the contact process.

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Koppers' Hot Actification Process is simple to operate. It uses a sodium carbonate solution to remove the hydrogen sulfide from the gas in an absorber, as shown in the flow sheet. The foul solution is regenerated by boiling under vacuum in the insulated column.

One plant treats 22,000,000 cubic feet of gas per day and produces approximately seven tons of H_2S per day, from which 20 tons of 66° sulfuric acid are made.

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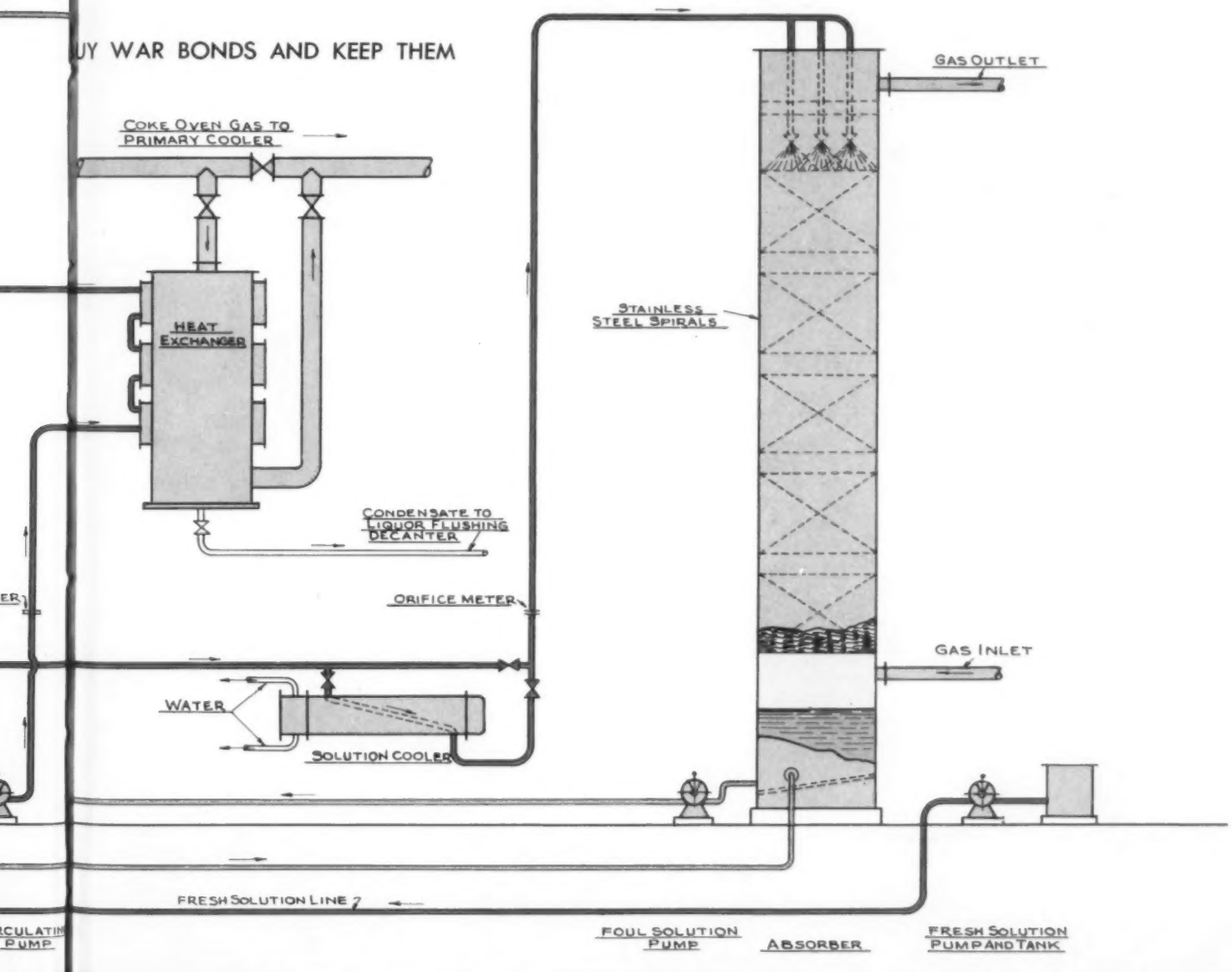

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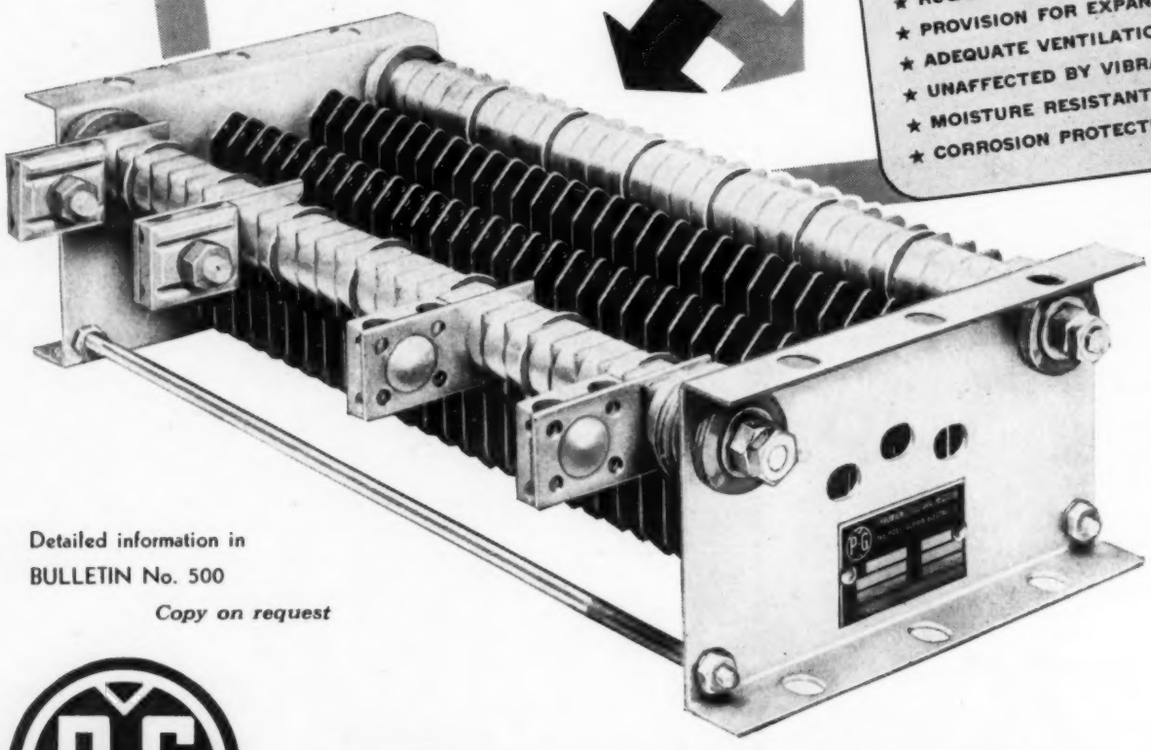

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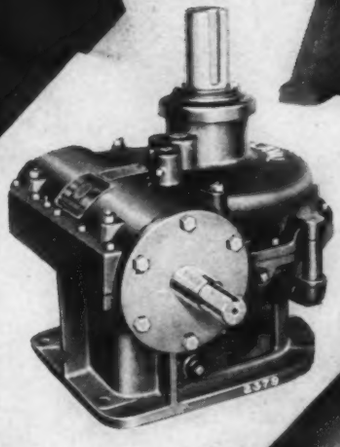

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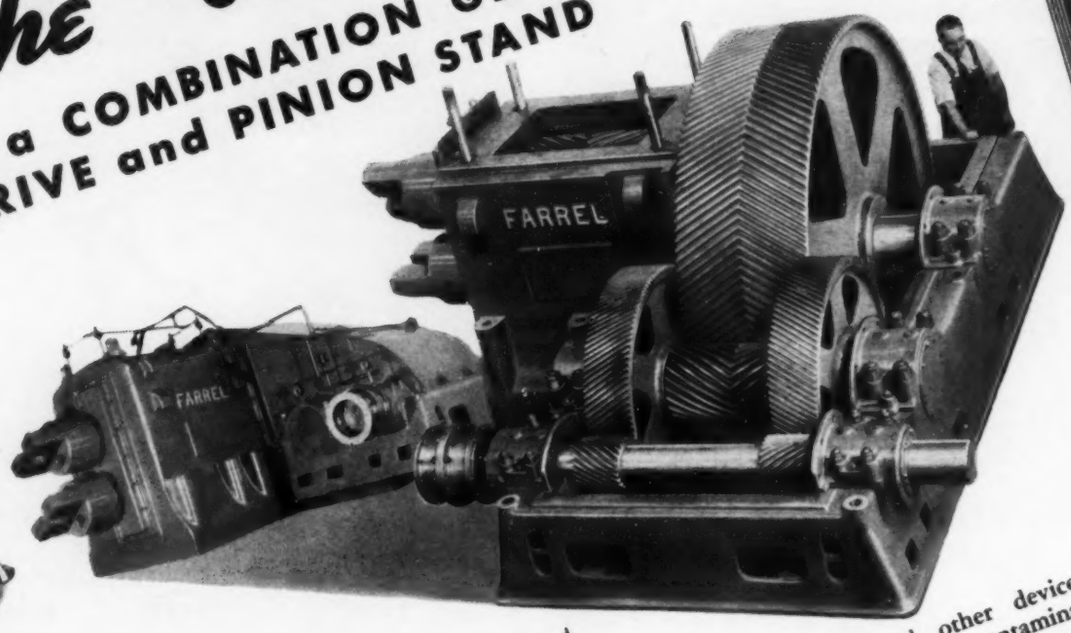

This is the main gear of the 1,250 HP drive illustrated at the right. It has Farrel-Sykes continuous herringbone teeth, is 10′ 7″ in diameter, 36″ face, and weighs over 13 tons.

This is the story of gears and pinions and the other "undercover" parts which make a rolling mill drive give a lifetime of satisfactory operation.

The drive illustrated is a combination reduction unit and pinion stand designed to transmit 1,250 HP to a 26-inch two-high mill. The first reduction consists of split (divided) double helical gears, and the second reduction gears and the mill pinions are the Farrel-Sykes continuous tooth herringbone type, a compact gear arrangement which distributes the load uniformly and requires minimum floor space.

With all shafts mounted in roller bearings, friction losses are reduced to a minimum, and efficient operation is further assured by effective lubrication. The main gears are dip-and-splash lubricated from a reservoir of extra large capacity, and the other gears and mill pinions and bearings are force-feed lubricated by separate pump. Automatically self-cleaning oil filters and other devices protect the drive against oil contamination or circulation failure. Housed in a heavy Meehanite case, with welded steel cover for the gear unit, maintenance of correct alignment of gears and pinions is made certain.

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NEWS SUPPLEMENT October, 1944

Equipment
Personnel
Literature

Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SAFETY PRECUATIONS ESSENTIAL WHEN WORKING ON SOLVENT TANKS

▲ The cleaning or repair of tanks in which organic solvents are used should not be undertaken without rigid precautions, inasmuch as the vapors of all organic solvents are toxic and the majority are flammable as well. Oxygen deficiency in the tank is another hazard which must be considered.

If a tank has contained a flammable solvent, the safest method for removing the vapors, preparatory to cleaning or repair, appears to be thorough flushing by steam, followed by mechanical ventilation of a type approved for flammable vapors. Steam jets to loosen sludge have been successful, the tank then being washed, drained and dried out with warm air. If the use of steam is impractical, the sludge may be washed out with high-pressure hose but care must be exercised to avoid building up static electricity. Steam also has some disadvantages, such as the building up of combustible mixtures at the vents. Non-sparking shoes and tools, vapor-proof lamps, and protective clothing should be utilized, and otherwise the Code for Flammable Liquids and Gases of the National Fire Protection Association should be observed.

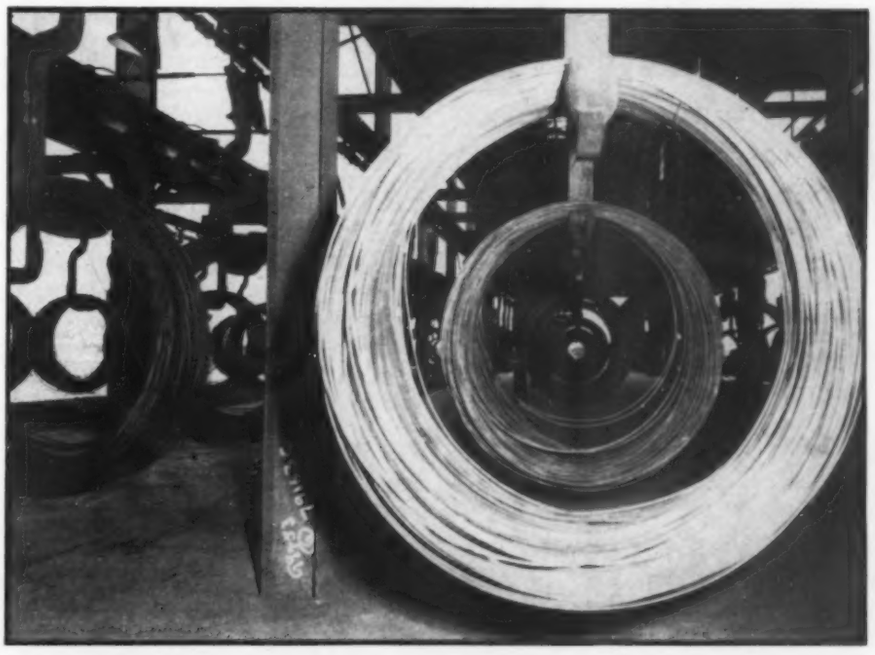
Before cleaning a tank that has contained a non-flammable solvent, the concentration of vapor in the tank should be reduced as much as possible, preferably by mechanical ventilation.

The cleaning of any tank that has contained an organic solvent should be done from outside the tank, if possible. In degreasing processes utilizing non-flammable solvents, where the process is wholly or substantially enclosed, metal chips, mud, and other solid residues are usually removed by scraping, and a clean-out door is generally provided through which the sludge may be removed by a long-handled scraper. The liquid residue and sludge are immediately confined, to lessen volatilization of the solvent in the atmosphere. An approved canister type gas mask is advisable

If cleaning from the outside is not possible, before entry into the tank, an air test by a competent chemist is advisable. Workmen who must enter should be further protected, preferably by air-line respirators approved by the U. S. Bureau of Mines for the purpose, though, in some cases, canister type gas masks approved for organic vapors may be used. Protective clothing should be afforded and there should be stationed outside the tank a watcher holding a rope or harness attached to the person inside, in order to haul him out at the first sign of trouble. Removal of protective apparatus should not be permitted until workmen are safely outside the tank.

Whether the tank is cleaned from the inside or outside, however, workmen in the surrounding area also should be protected from the possibility of vapor inhalation or the outbreak of fire. All organic vapors are heavier than air and tend to settle in low places, so that the atmosphere may be practically free of vapors at

CONVEYOR SAVES MAN-HOURS IN ROD MILL



This overhead trolley hook conveyor automatically picks up coiled rod from an apron conveyor and slowly moves them as they cool to loading stands. The coils are removed from the hook conveyor by pneumatic hoists. This conveyor, of a type unusual in steel plants, is installed in the recently completed rod mill of Columbia Steel Company, a United States Steel subsidiary, at Pittsburg, California.

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breathing level and yet contain a mixture that is explosive or hazardous to health at or near the floor or in a nearby pit.

Any recommendations provided by the chemical or equipment manufacturers should be carefully observed, and all workmen should be thoroughly drilled in safe practice.

EMPLOYMENT PROGRAM FOR VETERANS ADOPTED

▲ Carnegie-Illinois Steel Corporation has announced establishment within this U. S. Steel subsidiary's industrial relations department of a broad program looking to the re-employment of former employees returning from the armed forces and revealed the appointment of Maynard G. Montgomery as head of this activity.

Already this U. S. Steel subsidiary has employed more than 4,000 veterans of World War II, 2000 of them former Carnegie-Illinois employees who have returned to jobs at the steel company's plants and general offices. A follow-up record is being kept on each case, in line with the company policy, and special attention is being given handicapped veterans. To date, nearly 43,000 Carnegie-Illinois Steel workers have been inducted into service.

A former soldier, Mr. Montgomery served in the field artillery during World War I. He has been chairman of the Gary, Indiana Draft Board 7 from the time of its establishment in 1940. He has also had an extensive experience with returning servicemen during the course of his duties at the Gary plant of the corporation, where he most recently served as a general foreman.

NEW COKE OVENS FOR AUSTRALIA

▲ The Australian Iron and Steel Ltd. has awarded a contract to the Wilputte Coke Oven Corporation, of New York, for the engineering work on a battery of 48 Wilputte underjet, high and low burner ovens, including by-product equipment. This is an extension to the battery of 72 Wilputte ovens of the same type and to the by-product plant built in 1937 at Port Kembla, N.S.W., Australia.

LARGE HYDRAULICALLY CONTROLLED HACK SAW SHOWS MANY OPERATING ADVANTAGES

▲ Probably the most outstanding contribution to metal cutting equipment in recent years was the development, by Armstrong-Blum Manufacturing Company, of the giant No. 24 Marvel hydraulic hack saw with its extreme capacity of 25½ in. x 25½ in. In every installation and without exception, this saw is conserving both man and machine hours on large, essential War Work, at costs far below previous methods. Actual cutting time has been reduced more than one-half in some instances and the necessity for surface grinding test pieces entirely eliminated.

Multiple control of blade speeds, through a specially designed two speed gear case in conjunction with a Reeves variable speed drive, provides a range of from 20 to 80 strokes per minute, quickly and easily adapting the saw to any class of material to be cut. The 8 in. stroke develops 42 to 168 blade feet per minute, Further control is provided through a positive hydraulic feed, the setting of which is governed by the width of work, and a variable hydraulic feed which regulates the blade pressure in accordance to work resistance.

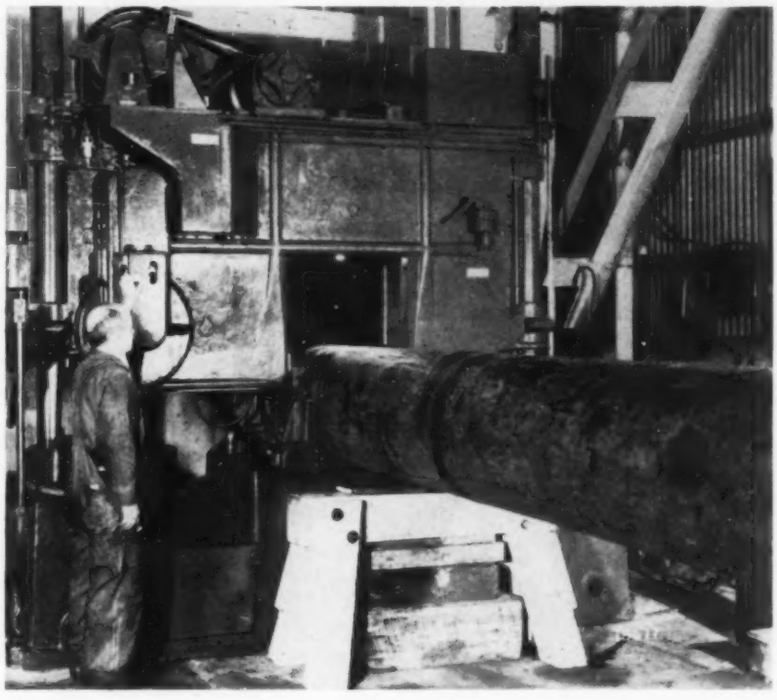
While the No. 24 Marvel cannot be termed in any sense a "blown-up" version of the time-proven model No. 18, heretofore the largest hack saw built, nevertheless, ten years' experience in building the latter model is reflected in the basic design and proven features incorporated into the newer, larger machine.

The entire hydraulic system is simple and efficient. As the system operates at extremely low pressures, leaks are a very unusual occurrence and all controlling units are subjected to very light loads. The hydraulic pump is required to operate only during those intervals when the upper housing is being raised for reloading the saw. The feed unit is a single, compact element designed especially to suit the exacting and sensitive control requirements.

The exclusive roll-stroke movement progressively raises one end of the blade and lowers the other as it is drawn through the work. This long-used and efficient Marvel principle solved a triple problem when cutting large work, as only a relatively short length of the blade is in contact with the work at any one instant and as a result, shorter chips are formed which do not clog the tooth gullets. Also, chips are progressively eliminated from under the blade and the required blade pressure is greatly reduced. Relief lift of the blade during the return stroke is accomplished within the upper housing itself, eliminating the raising and lowering of this unit each stroke.

Some idea of the enormity of the No. 24 saw may be had from the following figures. The total weight is 16,000 pounds and the saw frame alone weighs 900 pounds. Blade and holders 40 pounds. The high-speed-edge, chrome vanadium back Marvel blades are 31 in. x 4½ in. x ⅛ in. x 2½ teeth per inch, employing three pins in each blade holder, permitting a recommended blade tension of 17,000 pounds, insuring straight cuts and allowing higher feed pressure. Safety switches are built into the saw at several points, affording protection against both mechanical and human failures.

The first installation of these immense saws was made approximately one year ago and it has been operating twenty-four hours a day without interruption or one cent of repair expense ever since. Repeat orders — four from one company alone — quickly and simply answer performance and cutting cost questions. A typical No. 24 operation is pictured in the accompanying photograph taken at Mesta Machine Company, Homestead, Pennsylvania, showing the Marvel cutting a high carbon forging 22 inches in diameter by 54 feet long.



Cutting a 22 in. diameter high carbon forging is all in the day's work for this giant hack saw, which has a limiting capacity of 25½ in. x 25½ in. and operates at 20-80 8 in. strokes per minute.

MERGER OF FURNACE BUILDERS ANNOUNCED

▲ The Amsler-Morton Company, internationally known engineers in the steel and glass industries, announced a merger with Pennsylvania Industrial Engineers, Inc., Pittsburgh, which will continue operations as a division of Amsler-Morton in the Fulton Building, Pittsburgh. Oscar R. Olson, formerly President of Pennsylvania Industrial Engineers, Inc., has been elected President of The Amsler-Morton Company, and the announcement named the following additional officers: Karl W. Gass, Executive Vice President, Paul M. Offill, Vice President-Sales, Arch V. Ritts, Vice President P.I.E. Division, Theodore H. Sloan, Vice President G.M.S. Division, and T. E. Roop, Vice President-Purchasing.

J AND L SETS NEW PRODUCTION RECORDS

▲ Recent victories by Allied forces have not caused any let-up in the production drive at the various works of the Jones and Laughlin Steel Corporation but instead have spurred the workers on to even greater efforts. In September, a thirty day month, which also included a holiday for some finishing departments, J & L plants at Pittsburgh, McKeesport and Cleveland established new high production records in several departments.

The Otis Works, Cleveland, established a new record for total iron and steel products shipped which was nearly 2500 tons higher than its best record of September 1943. The Otis blast furnaces bettered their record established only a month ago and the 77-inch hot strip mill bettered its record, March 1944. At this works, the No. 26 open-hearth furnace and the sinter plant also broke their best previous records.

At Pittsburgh Works, the No. 4 blast furnace broke its best record, that of October 1942, and the Soho fragmentation bomb line bettered its August, 1944 record by more than 60 per cent.

At McKeesport Works ordnance plant the production of eight-inch shells for the famed "Black Panther" and the big howitzer was increased by more than 35 per cent. Ranking U. S. Army Ordnance officers have complimented J & L several times on the splendid performance of this plant in producing these critically needed shells.

ELECTRICAL MANUFACTURER GETS MARITIME "M"

The 153d Maritime "M" to be awarded to a manufacturing concern went to the Reliance Electric and Engineering Company in a ceremony at the Cleveland plant on September 16. Admiral Howard L. Vickery, vice chairman of the Maritime Commission, presented the pennant to Charles L. Collens, president of Reliance, whose Marine Departments have been outstanding in the engineering and production of motors and generators which supply power for the Victory fleet in more than fifty installations. Reliance units of ratings from ¼ to 150 horsepower perform a variety of tasks, ranging from the operation of main circulating and condensate pumps, steering gear, 5 in. guns and searchlights, to the "little jobs" of running refrigerators, garbage grinders, fire and sanitary pumps on Victory ships, tankers, transports, cargo ships, barges, tugs, and converted aircraft carriers.

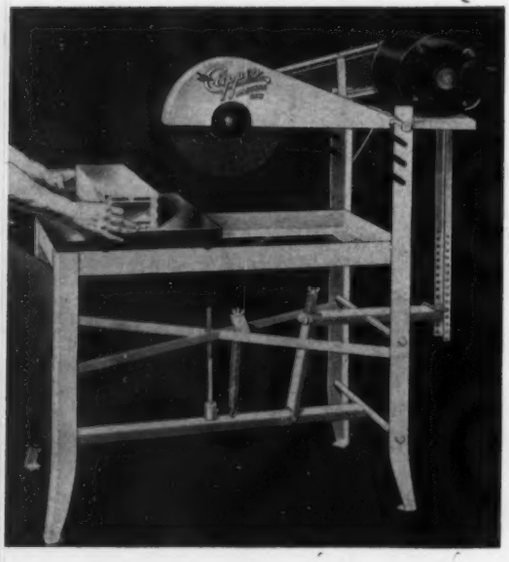
SAW CUTS MASONRY TO EXACT SIZE

▲ Quicker, more accurate, more efficient and economical cutting of refractories and masonry materials — these are the results obtained when using a Clipper masonry saw. Designed especially for cutting special sizes and shapes of firebrick, this equipment will prove to be of value wherever furnaces, acid chambers or kilns require linings or repair work.

The "multiple cutting principal," a special feature of this saw, utilizes a series of rapid, shallow cuts which discharge cuttings and reduce frictional heat. Smooth cuts, accurate to within a fraction of an inch, easily made on clay, chrome, magnesite, silica and acid resistant brick.

Seven different models are available, each of sturdy steel frame construction with electrically driven motors. Gasoline model, also, for use in outlying districts where electricity is not available. All models are completely portable and may be moved about wherever needed.

This masonry saw can be conveniently moved to the job, and insures accurate fits in brickwork.



BREAKER FEATURES COMPACT DESIGN

▲ A new 100-ampere "De-ion" circuit breaker which requires less space and permits lighter structures for distribution panelboards, built-in applications and bus duct plug-ins is announced by Westinghouse Electric and Manufacturing Company.

All ratings are available in one compact breaker with uniform pole spacings and terminal arrangement, providing complete interchangeability between ratings. The new F frame permits for the first time a 100-ampere, 600-volt a-c or 250-volt d-c breaker in the same space formerly required by the 50-ampere, 600-volt a-c or 250-volt d-c rating.

Equipped with thermal and instantaneous magnetic trip elements, the "De-ion" fuseless circuit breaker permits maximum loading of circuits and fast resumption of interrupted service. Contact pressure increases with wear, thereby prolonging the life of contacts and breaker. Silver alloy contacts give increased contact life with lower wattage loss. The special alloys used also prevents "freezing." Both two and three-pole units are available.

PROGRESS IN ELECTRIC LIGHTING REVIEWED

▲ Carved in stone near the entrance of the Archives Building in Washington are the words, "What Is Past Is Prologue."

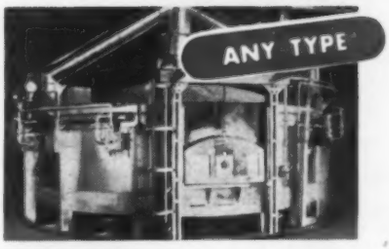
All of our yesterdays are a prelude to today and today is but a prologue for the progress of tomorrow. Perhaps there is no better way to forecast post-war lighting than to search the past for its prophecy of the future. By a study of the record of thirty years of lighting progress, by comparing 1913 with 1943, perhaps we can answer some of the questions which you and your customers ask today about the lighting of tomorrow. We know that engineering advancement must continue. We are certain that new design is a prerequisite of lighting progress. And, if the lighting of the future is to meet the needs of tomorrow, there is little doubt that closer cooperation between manufacturer and distributor is essential.

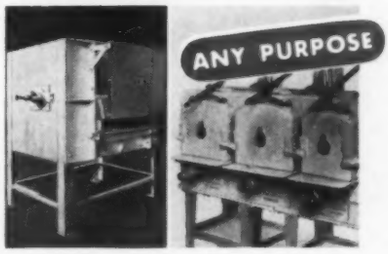
Back in 1913, thirty years ago, five footcandles of general illumination was accepted in the better lighted interiors just as fifty or one hundred footcandle levels are today. At that time, a 100-watt vacuum tungsten lamp then newly introduced cost 80¢ and yielded approximately nine hundred lumens of light. Today the 100-watt fluorescent lamp gives 4200 lumens, or nearly five times as much as its first prototype. The cost of current now averages less than half as much as it did in 1913 so that users get ten times as much light for the same amount of money. Perhaps it's more than a coincidence that lighting standards, too, are about ten times what they were in those earlier days.

This substantial improvement in light production presupposes that sometime in the future, certainly within the next thirty years, a radically new light source will be discovered or invented, something not now conceived of at all. This, too, seems very probable. The time to look for such inventions is when every possibility for improvement of existing sources seems to have been investigated and there are no avenues of opportunity left. After tungsten lamps were placed on the market, lamp manufacturers went through several years of worthwhile refine-

"Working-it-out" conferences between metallurgist, combustion engineer and furnace designer insure the best, most practical solution to your heat-treating problems.

. . . to put your post-war product on a profit basis





DON'T let out-moded, inefficient and costly heat-treating procedures handicap you when the day arrives to resume peacetime operations.

War's needs have accelerated the development of improved heat-treating techniques designed to get out of steel *all* of the predetermined properties put into it by the steel maker.

Properly applied, *modern* heat-treating—as typified by Austempering, Martempering and Purnellizing—insures improved and more uniform physical properties. Increases machinability. Reduces warpage. Provides freedom from soft spots and cracking. It minimizes re-treating and rejections. The result—a better product at lower cost!

Here at Tate-Jones we offer you thorough and practical knowledge of these advanced heat-treating methods—as well as of conventional heat-treating practice.

We can furnish not only expert metallurgical and engineering advice to improve your heat-treating but can provide the proper equipment to exactly fit your needs:—oil and gas-fired furnaces of all types, either standard or custom-built—salt and lead pots—oil tempering tanks of the latest type—all engineered to operate at maximum efficiency and to give you the results desired.

46 years experience building quality industrial furnaces and heat-treating equipment is behind this service.

FURNACE ENGINEERS

TATE-JONES

& CO. INC. · LEETSDALE *(Pittsburgh District)* **PA.**

Rotating Hearth, Car Bottom, Pusher, Conveyor, Roll Down, Horizontal and Vertical Pit, Circular and Rectangular Pot Furnaces. Also Gas, Oil and Combination Burners

ments. Then, just when we were about to write finis on tungsten lamp efficiency, out of our laboratories came the epoch-making gas-filled lamp, and the whole process of refinement started all over again. And when we appeared to be just about finished with the major improvements in gas-filled lamps, fluorescent appeared on the horizon. Today, it is still in the refinement stage. Radical inventions usually cannot be foreseen; refinements usually can. What are the possibilities of further refinement in fluorescent? Possibly a fluorescent lamp that needs no ballast or starter, one that can be seated in a socket to have it light. Actually such a lamp would not be a refinement at all but a fundamental invention. An electric discharge source that does not require a ballast or choke to keep it from running away to short circuit is quite contrary to everything we know today. Even the old carbon arc lamp had to have a ballast. On the other hand, a lamp which will start without the help of a starting-switch already has been announced.

We can also look for continued improvements in fluorescent lamps from the standpoint of candlepower maintenance. Early G-E laboratory samples dropped to one-half candlepower in 400 to 500 hours. Now the figure is 85 per cent at about 2000 hours and we can expect to go still further. Nor is the question of refinement in initial efficiency a closed book. There are still possibilities in new phosphors and sixty lumens per watt instead of fifty-two for the 40-watt lamp does not appear unreasonable. Substantially higher wattages in fluorescent lamps are quite possible. We already know that we can make longer tubes and are planning to make them. Anything beyond these known improvements, today, had better be put into the category of radical invention.

What about new shapes in fluorescent lamps — curves, half circles, angles? Any of these can be made, but if too many types are designed it is questionable whether the wholesaler and his customers would be benefitted. Already, our laboratories have designed circular lamps for manufacture as soon as priorities permit.

Before other new shapes can be designed, three factors must be considered. Two principal factors so far as the consumer is concerned are cost and convenience. It must be perfectly obvious that too wide a variety of curves would be costly. At the same time, stocks would be difficult to maintain and replacement lamps would certainly be less convenient to obtain.

Postwar lighting equipment is certain to be even more largely fluorescent than ever before. Design will tend to be more functional and less ornamental, both in industrial and commercial markets. For new lighting or the relighting of most types of interiors, postwar, the demand for fixtures will tend toward flush mounting and with war experience as a guide, a high percentage of continuous-row or large-area installations will be made. In most new buildings recessed or flush-mounted fixtures will distribute cool, soft, even light on working surfaces. Combinations of fluorescent with versatile filament lighting will continue to spotlight and highlight industrial process and commercial displays.

Are you interested in Saving

MAN-POWER
FUEL
MATERIAL

This Gage will do it!

HAYS VISIO-RATIO GAGE

IT SAVES IN MAN POWER because it eliminates the necessity of making calculations to determine air excess or deficiency—does away with lost time in making experimental adjustments.

It saves in fuel because it indicates instantly when there is an incorrect proportioning of air and fuel. It is an infallible guide to highest possible combustion efficiency.

It saves in material through producing greater uniformity in production methods, in minimizing spoilage, etc. It may be used for indicating not only the ratio of air flow to fuel flow—but the ratio between other functions such as pressure, draft, suction, temperature (up to 1000° F) speed in R.P.M. or inches per minute, position, level and others.

The cross-pointer feature is exclusive with the Hays Visio-Ratio Gage. It shows at a glance not only the amount of the two flows but the percentage of excess or deficiency existing between them.

The HAYS CORPORATION
MICHIGAN CITY, INDIANA, U.S.A.

Send for
PUBLICATION 41-478
ON CENTRALIZED
CONTROL OF OPEN
HEARTH FURNACES

NEW PNEUMATIC OPERATING VALVE

▲ A new compressed air foot valve to be used with air tools, air cylinders, air chucks, flash welders, forging machines, die casting machines, riveting machines, air vises, and all other air operated equipment is announced by the manufacturer, Keller Tool Company, Grand Haven, Michigan.

On tools, where it is desirable for operators to have both hands free, it greatly facilitates rapid handling of work. Safety of the operator is accomplished by the kick guard which prevents accidental operation.

This foot valve is furnished in locking and non-locking types. The pedal lock on the locking type holds the pedal in the open position. A touch of the operator's toe releases the lock.

A simple adjustment of the lever-locking device prevents engagement of the operating pedal and changes the locking type to the non-locking type.

The valve mechanism is simple. Normally, the valve is closed with the outlet side open to the exhaust. When the foot pedal is depressed, the exhaust closes and line pressure is admitted to the device to be operated. Upon release of the pedal, the air supply stops and the outlet to the exhaust is again opened.

Rugged construction features include: Heavy cast iron body; neoprene valve seat; heat treated and precision ground valve operating stem; heavy gauge steel kick guard; brass screen air strainer. Net weight: 12½ lbs.

CHILE PROGRESSES IN ELECTRIFICATION

▲ An extensive program of electrification is now taking place in Chile to speed industrial expansion there, and the International General Electric Company has been awarded contracts to supply a great amount of the needed generating, transmission and distributing equipment, officials of the company have disclosed.

Three large plants have already been scheduled for production by the Corporacion de Fomento de la Produccion, the Chilean government agency in charge of the development, and more are planned for the near future. According to the report of I.G.E. officials, a sizeable steel mill will also be built in addition to the power plants. When completed it will be the first such plant to be located in Chile as well as the first on the west coast of South America.

To supply power for the steel mill and for coal mines and textile mills, I.G.E. has agreed to send the Abanico hydroelectric plant — the newest in the development — the largest generator units ever shipped to the country, as well as transformers, switch gears and other equipment.

The huge generators will make it possible for the hydro-electric plant to produce power at an ultimate capacity of 130,000 kva, about one-fourth the present capacity of the Bonneville hydroelectric in this country. Projected output of the steel mill is more than 100,000 tons a year.

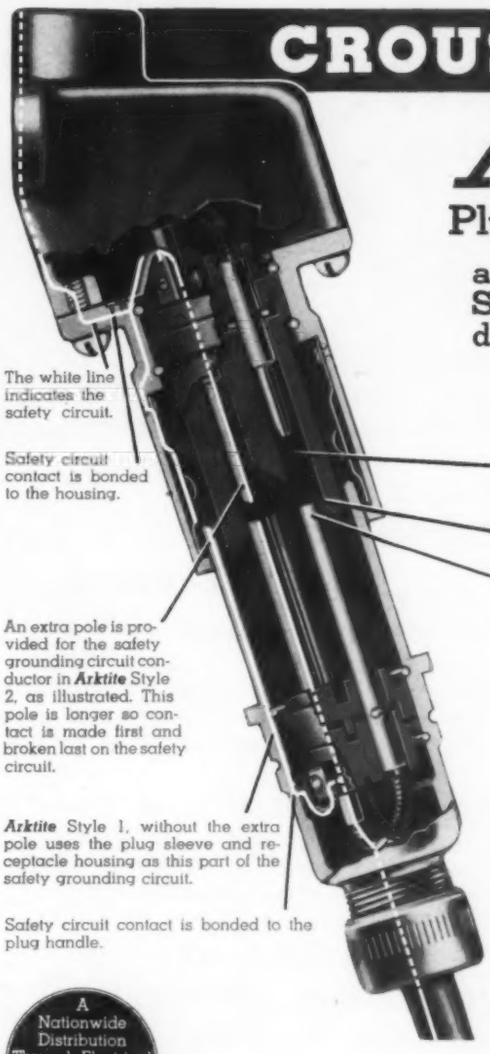
The Abanico plant will be located on Laja River, in the southeastern part of Chile. A 21,500-acre lake was formed there about 85 years ago when Antuco Volcano erupted, throwing a lava dam across the path of the river between two mountain ranges. The lake is so deep that available sounding devices have never reached its bottom.

CROUSE-HINDS

Arktite

Plugs and Receptacles

are circuit breaking and SAFE without additional disconnect equipment.



The white line indicates the safety circuit.

Safety circuit contact is bonded to the housing.

An extra pole is provided for the safety grounding circuit conductor in *Arktite* Style 2, as illustrated. This pole is longer so contact is made first and broken last on the safety circuit.

Arktite Style 1, without the extra pole uses the plug sleeve and receptacle housing as this part of the safety grounding circuit.

Safety circuit contact is bonded to the plug handle.

The arc formed by pulling the plug is instantly snuffed in the confined insulated arcing chamber.

Each plug contact fits closely the opening of its individual arcing chamber.

The arc is broken while the plug contact is still a considerable distance inside of the arcing chamber. There is no danger of the arc traveling over to the other side of the circuit or to the housing.

CROUSE-HINDS offers the only complete line of circuit breaking plugs and receptacles 20 Amp. to 400 Amp., 250 volt D.C., 600 volt A.C.

Arktite plugs and receptacles are listed in Condulet Catalog No. 2500, Section 40. Explosion-proof Arktite plugs and receptacles are listed in Section 85, "Condulets for Hazardous Locations."

A Nationwide Distribution Through Electrical Wholesalers

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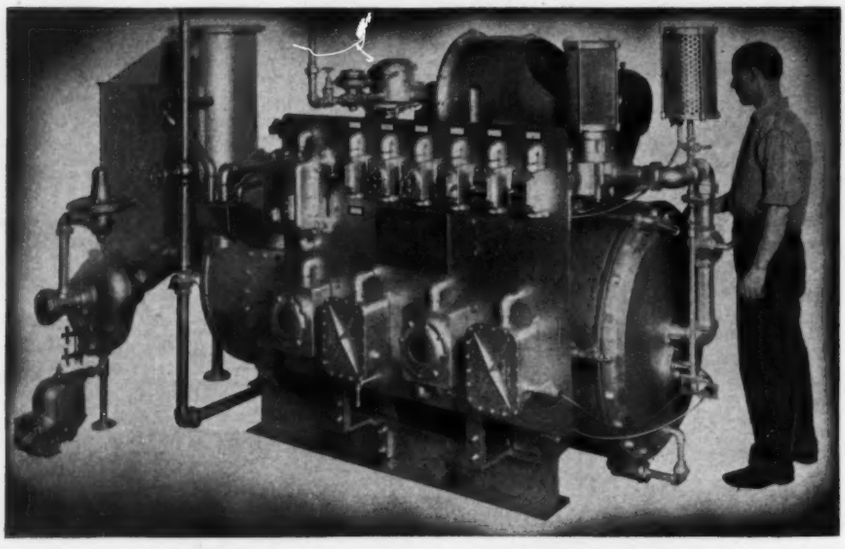
New Literature

▲ The Cleveland Worm and Gear Company, Cleveland, Ohio, is mailing a four page illustrated bulletin which embodies a concise description of the new Speedaire fan cooled worm gear reduction units. A large illustration in the center spread of this bulletin shows just how the high velocity air stream is held on a directed course by the double wall housing, how the heat-dissipating surface is nearly doubled by integrally cast fins on the outer wall of the housing. It is pointed out that because of the more effective removal of heat the Speedaire unit delivers up to twice the horsepower capacity obtainable from standard type worm reducers of equal size, when operated at the usual motor speeds.



For Purging—
For Blanketing—
For Processing—

Specify the Kemp Inert Gas Producer where processing conditions or requirements call for inert or protective atmospheres.

Kemp Inert Gas Generators are available in capacities ranging from 1,000 to 100,000 cubic feet per hour, may be furnished for semi-automatic or automatic operation. Safety features include electric ignition, safety pilot, soft heads, fire checks, and automatic shutdown in the event of

(a) burner outage (b) cooling water failure, or (c) fuel gas supply failure.

The inert atmosphere is delivered at a temperature of not more than 15° F. above the inlet temperature of cooling water with a corresponding dewpoint. When dryer gases are required, low dewpoints may be obtained by selection of suitable auxiliary drying equipment. Write for engineering data, recommendations, and quotations.

Ask for Bulletin 901.3

OTHER KEMP PRODUCTS

Adsorptive Dryers for Air and Gas
Atmos-Gas Generators for Special Atmospheres
The Industrial Carburetor for premixing gases
Immersion Heaters
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore-2, Maryland

KEMP of BALTIMORE

▲ The Askania Regulator Company has just published bulletin No. 101 on ratio control. It points out the manner in which Askania ratio control may be applied to many types of proportioning applications in the process industries.

A novel feature of the bulletin is the orifice calculation chart. This offers engineers a quick and easy method of orifice size determination for air and gas flows.

Copies of this bulletin may be obtained upon request.

▲ Cochrane publication 2975 is descriptive of Cochrane decarbonators for removing certain dissolved gases from water solution.

These decarbonators have been successful in application for removal of carbon dioxide in connection with iron removal plants and with the degasification of hydrogen zeolite softened waters.

Data is available and description is given of the method of operation and can be had for the asking.

▲ "A Complete Data Book on Worm Gear Speed Reducers for Industrial Applications" is the title of a new book No. 1824, which Link-Belt Company announces has been completed and is now available for distribution to interested readers.

It is a book of 100 pages, replete with photographs, dimensioned line drawings, engineering data, horse power ratings, and tables of weights and dimensions, all aimed at helping the holder of the new book to make his own selection of the type and size of reducer required for a specific service.

A copy of new book No. 1824 may be had by writing direct to Link-Belt Company at Philadelphia, Chicago, San Francisco, or other offices of the company.

▲ The result of many months' laboratory research, a study titled "Shot Peening and the Fatigue of Metals," by H. F. Moore, for many years Research Professor of Engineering Materials at the University of Illinois, has been published by American Foundry Equipment Company, Mishawaka, Indiana. Among the subjects covered are: Types of structural damage of metals, how shot peening increases resistance to plastic distortion, the origin of fatigue cracks, the effects of cold working, measure-

Heavy-Duty Safety Switches and Circuit Breaker Pylets

BUILT FOR MILL AND RAILROAD SERVICE

Circuit breaker Pylet with interlocked receptacle and QuelArc plug.

Pyle-National safety switches have the substantial construction needed to withstand severe operating conditions. The case and cover are heavy-section galvanized cast iron; operating parts are of heavy cast metal, and are designed for quick make and break action. Contacts are mounted on heavy slate. The operating shaft has bronze bearings. The case is fully protected, with both cover and hub plates equipped with weatherproof gaskets. The operating lever extends through the case in a rustproof bearing, and the cover is held closed by rustproof wing nuts and bolts. These features assure dependable service and long life even under severe operating conditions.

Circuit breaker Pylets are of similar heavy duty construction, and are available with or without interlocking receptacle for QuelArc plugs.

Write for Pylet general Catalog 1100 with complete listings.

PYLE-NATIONAL
ELECTRICAL EQUIPMENT
• SINCE 1897 •

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CONDUIT FITTINGS • FLOODLIGHT PROJECTORS

LOCOMOTIVE ELECTRICAL EQUIPMENT

ment of shot peening intensity, examples of increased fatigue life from shot peening, and many others. The booklet is illustrated by microphotographs, charts and tables, and contains research data never before published.

▲ A 20-page booklet has just been issued by Tube Turns, Inc., of Louisville, Kentucky, giving allowable working pressures for welding fittings in five classes of piping — power, oil, district heating, gas and air, and refrigeration. Fourteen convenient tables list allowable pressures at the indicated temperatures for any size and weight Tube-Turn fitting. All tabulations are made in accordance with the Code for Pressure Piping A.S.A. B31. 1 — 1942.

▲ Evidence of the growing interest in the South American markets is shown in the trade bulletins appearing in Spanish. Latest to appear is the new Aerator Cooling Tower Bulletin (Fluor Torres Enfriadoras Aerator) published by The Fluor Corporation, Ltd., Los Angeles, California.

▲ Surface Combustion, Toledo, Ohio, has just published two new bulletins setting forth some of its furnace products. One of these, "Surface Combustion Furnaces In the Production Line," illustrates the modern trend of placing the heat treating operation directly in the flow-line of plant operations, rather than the old practice of a separate furnace room or heat-treat department. The second bulletin, on "Soft Metal Melting" shows miscellaneous melting furnaces for a temperature range of 500-1200 F. Copies may be had upon request.

▲ Preferred Utilities Manufacturing Corporation report a recent increase in requests for copies of their 36-page service booklet, "Dividends From Your Power Plant." They attribute this to the rapidly growing interest in post-war planning.

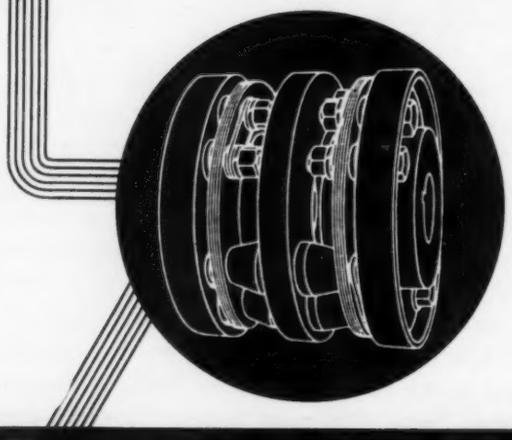
This booklet is not an advertising pamphlet, offers nothing for sale. It is published as a service to power plant engineers and executives, to help them to a better understanding of steam producing problems, as well as appreciation of the plant engineer and his job.

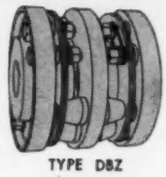
The booklet consists of a compilation of ten non-technical discussions by men who are authorities on steam generating. Each article handles a different phase of power plant operation and supplies much useful information that busy main office executives ought to have, yet rarely find time to acquire.

Copies are obtainable by writing Preferred Utilities Manufacturing Corporation, 1860 Broadway, New York 23, N. Y.

▲ Chain Belt Company has just produced a new folder descriptive of Rex Flat Spray Nozzles. These nozzles are in service in practically all industries where water is used in cleaning, cooling and washing operations. They are made in a variety of sizes and from a variety of materials. The folder besides illustrating and describing the nozzle uses gives tabular information concerning their discharge in gallons per minute; their dimensions; a list of materials, sizes and prices.

THOMAS
Flexible COUPLINGS

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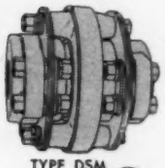
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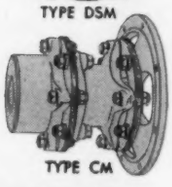
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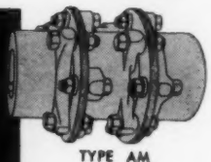
Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.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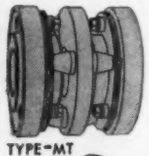
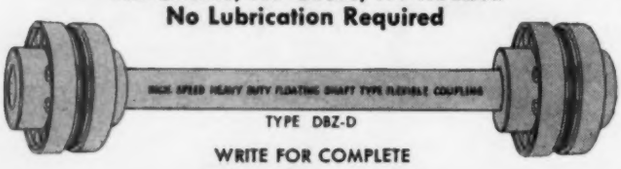

TYPE-MT

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required


TYPE DBZ-D

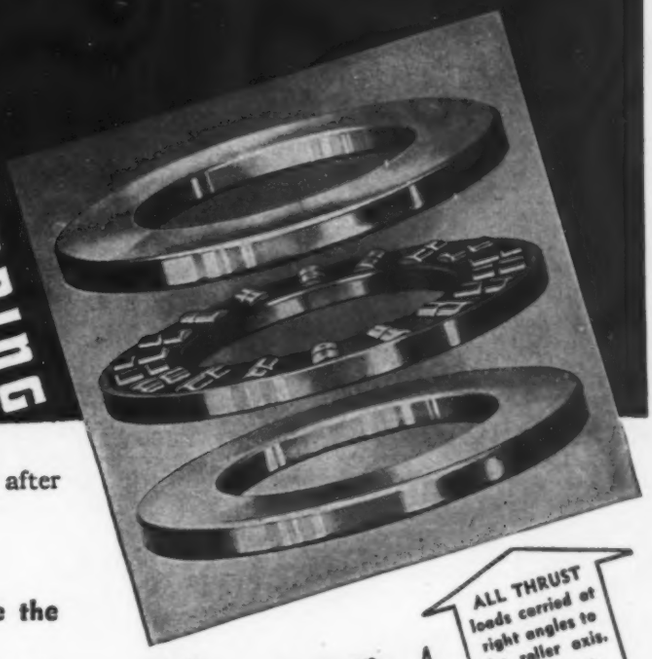
TYPE SS

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

More Bearing Performance at Lower Cost . . . with

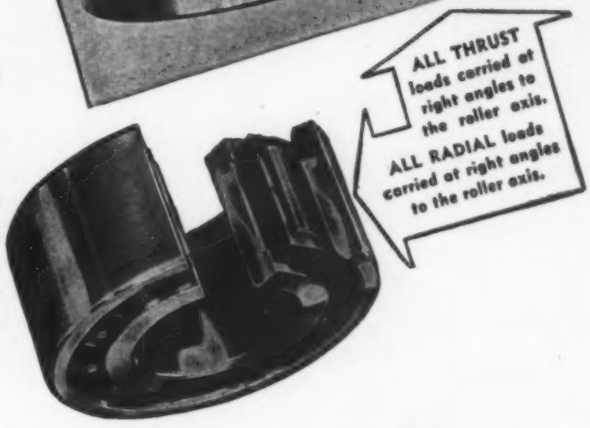
ROLLWAY
RIGHT-ANGLE LOADING



Of course, you'll have to sweat out extra production after the war in order to . . .

1. **Hold your competitive position**
2. **Break into new markets**
3. **Cash in on the flood of postwar orders before the peak demand dries up**

So, right now, make sure that the new designs on your drafting boards are developing around these high-performance, heavy-duty bearings. Bearings that insure longer life at higher speeds, and under heavier loads.



For longer bearing life, more efficient performance and more economical maintenance . . .

FOLLOW THIS BASIC BEARING PRINCIPLE

- All radial loads carried at right angles to the roller axis.
- All thrust loads carried at right angles to the roller axis.

RIGHT ANGLE LOADING IS THE REASON

One look at the diagram tells you why Rollway's right-angle loading insures more performance per unit of cost. There are no compound loads to muddy up the stress analysis or to aggravate wear and cause premature failure. Loads are resolved into their simplest components of *pure radial* and *pure thrust*. And each of these separate components is carried by a separate roller assembly AT RIGHT ANGLES TO THE ROLLER AXIS. That means oblique resultants and compound forces are out.

There's no squeezing action to force the rollers from between the races, hence less end-rub and less roller-end wear back. Each separate assembly safely carries heavier loads at higher speeds, or gives proportionately longer life at the same load and speed.

DON'T DELAY Send a sketch, drawing or detailed specification for free bearing analysis by Rollway engineers. The right type of bearing will make a vast difference in the ultimate performance and market for your product.

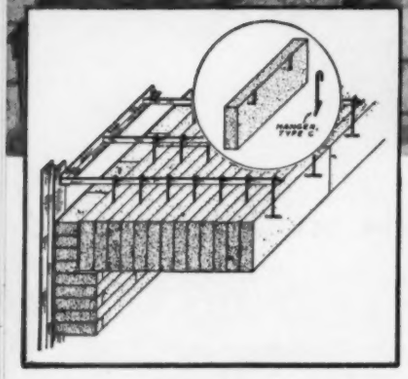
ROLLWAY BEARING COMPANY, INC., SYRACUSE, NEW YORK

BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

Reline Furnaces *twice as fast*

with big, new J-M Insulating Fireblok



Placing the new J-M Fireblok in a suspended arch-type furnace. Despite the large size of Fireblok, it is easily handled because it is light in weight. Diagram shows this arch construction in greater detail.

YOU CAN GET your furnaces back in service much quicker, thus making substantial savings in down time as well as maintenance crew time by using big, lightweight Johns-Manville Insulating Fireblok. For one Fireblok covers more surface than five regular-size fire brick and, therefore, is much easier and quicker to place.

Easy cutting and fitting—J-M Fireblok can be easily cut with a saw and shaped with a rasp. Most special shapes can be either shop or field cut from standard slabs, reducing the inventory of special shapes.

Minimum of joints—the large size, compared to the standard fire brick unit, materially reduces the number and length of joints, resulting in a thermally more efficient construction.

Economical bonding—with reduced joint length Fireblok requires a minimum of air-set cement for bonding. (J-M 1626 Cement was especially developed for this use.)

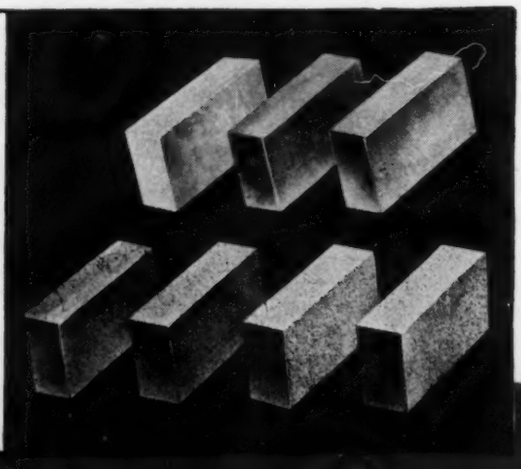
Uses—Fireblok can be used wherever Insulating Fire Brick are recommended such as for heat-treating furnaces, flues, stacks, mains and similar equipment. Also for the lining of doors, suspended arches, and, when tapered, for sprung arches of exceptional stability.

* * *

For further details on the many Johns-Manville Insulations for Steel Mill Service, write for catalog GI-6A, Johns-Manville, 22 East 40th Street, New York 16, N. Y.

For efficient, long-lasting insulation, try J-M Insulating Brick and Insulating Fire Brick. 7 types are available.

3 types of Insulating Brick: Sil-O-Cel Natural Brick for temp. to 1600° F; Sil-O-Cel C-22 Brick to 2000° F; Sil-O-Cel Super Insulating Brick to 2500° F. 4 types of Insulating Fire Brick: JM-1620 to 1600° (or to 2000° F. behind refractory protection); JM-20 to 2000° F; JM-23 to 2300° F; and JM-26 to 2600° F. All provide lightweight, low cost, low conductivity. Insulating Fire Brick differs from J-M Insulating Fireblok *only* in size.



JOHNS-MANVILLE JM PRODUCTS

Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

Personnel News

J. Emmett Fink, general works manager for Great Lakes Steel Corporation, has been appointed vice president in charge of operations for the company. He will continue as works manager of mills which are the government's chief source of supply for landing craft armor plate, Quonset huts and other wartime products.

Julius A. Clauss, chief engineer of Great Lakes Steel for many years and former War Production Board official, has been named vice president in charge of engineering.

Both Mr. Fink and Mr. Clauss have been with Great Lakes Steel since it was organized in 1929, and prior to that had been in the steel business many years. Mr. Fink entered the steel industry in 1907 as a sheet mill worker in Allegheny Steel Company's Brackenridge, Pennsylvania Plant. From 1912 to 1917 he worked as a hot mill stocker and in other capacities for the West Penn Steel Company. Shortly after formation of Great Lakes, J. Emmett Fink became superintendent of its merchant mills, assistant general superintendent in 1935, general superintendent in 1940 and general works manager in 1941.

Mr. Clauss, who in 1929 and the early nineteen thirties directed construction of the Great Lakes plant at Ecorse, Michigan, in 1943 served as special assistant to the director of WPB's Steel Division in charge of steel plant facilities. Before joining Great Lakes Steel in 1929 he had been associated with the Trumbull Steel Co., Warren, Ohio, Republic Iron and Steel Company, Youngstown, Ohio, Corrigan-McKinney Steel Company, Cleveland, Ohio, Carnegie Steel Company, Youngstown, and Lackawanna Steel Company, Buffalo, New York. In 1940, Mr. Clauss was president of the Association of Iron and Steel Engineers.

Fred G. Teufel, district manager of the Storage Battery Division of Philco Corporation in Cleveland, has been named midwestern sales manager of the Division which includes supervision of offices in Buffalo, Pittsburgh, Cincinnati, Detroit, Chicago and Cleveland. He also becomes a member of the management staff at headquarters.

Teufel is well known in the storage battery industry throughout the United States. He spent 23 years with the Willard Storage Battery Company in several capacities, serving as sales manager for 12 years, prior to joining Philco in January, 1941.

Walter A. Furst has been appointed district representative in the Pittsburgh area for the Storage Battery Division of Philco Corporation.

Mr. Furst, formerly general contract manager for the Westinghouse Electric and Manufacturing Company and subsidiaries, is a graduate of the University of Maryland.

J. M. Stapleton, former superintendent of blast furnaces for Geneva Steel Company, Geneva, Utah, has been promoted to assistant division superintendent of blast furnaces at South Works of Carnegie-Illinois Steel Corporation. Both companies are United States Steel Corporation subsidiaries, and Mr. Stapleton is again joining Carnegie-Illinois at the South Chicago plant succeeding the late **R. D. Beck.**

Mr. Stapleton is returning to the plant at which he worked for twenty-two years prior to joining Geneva Steel Company last October. His first employment at South Works goes back to 1921 when he was a gas pressure operator. Frequent promotions soon advanced him to general foreman and in May, 1939, he was made superintendent of the 1-4E blast furnaces, the post he held until leaving in 1943.

A graduate of the University of Chicago, Mr. Stapleton is the winner of the 1943 J. E. Johnson Award which is presented by the American Institute of Mining and Metallurgical Engineers for the outstanding technical paper of the year.

At Geneva Steel, Mr. Stapleton is succeeded as superintendent of blast furnaces by **J. S. McMahon,** who formerly was assistant blast furnace superintendent

J. EMMETT FINK

JULIUS A. CLAUSS

J. M. STAPLETON

at the Warren, Ohio, plant of Republic Steel Corporation. Before joining Republic, Mr. McMahon had been associated with the National Tube Company, another United States Steel subsidiary, in the blast furnace department at Lorain, Ohio.

Harry J. Fisher and **R. J. Cox,** Cleveland, Ohio will represent Pennsylvania Transformer Company in the Cleveland territory for its complete range of transformers. The company also announced that Electrical Jobbers Equipment Company, Minneapolis, Minnesota, will handle the company's line of power, distribution, welding, furnace and other types of transformers in that district.

Harold C. Olson has been appointed sales manager and **John A. Toth** as assistant sales manager of The Torrington Company, Bantam Bearings Division, South Bend, Indiana.

Mr. Olson studied Mechanical Engineering at the University of South Dakota and has been with The Torrington Company since 1935. He was formerly district representative in Milwaukee and Pittsburgh and became assistant sales manager in 1941.

Mr. Toth has been associated with Torrington since 1929. Also at one time Pittsburgh representative, he was special representative in the steel industry before his present appointment.

George R. Roemer has established consulting engineering services in Pittsburgh, Pennsylvania, offering complete investigating, reporting, planning and estimating services for reconversion, alteration or expansion of existing steel and industrial plants.

C. W. Camp, formerly with Crocker-Wheeler Electric Manufacturing Company for 38 years, specializing in application engineering, is now associated with Worthington Pump and Machinery Corporation, Harrison, New Jersey, as consulting electrical engineer.

A former executive member of the National Association of Electrical Manufacturers, Mr. Camp brings a wide background of experience in the electrical industry to his new work with Worthington's public utilities department.

Howard B. Carpenter, after sixteen years with Republic Steel Corporation and its predecessor companies and for the last five years assistant vice president in charge of operations, has resigned and will open an office in Cleveland as a consultant in steel mill operations.

Mr. Carpenter was born in Pittsburgh and was graduated from the University of Michigan in 1906 as a chemical engineer. He was associated successively with the metallurgical and open hearth departments of the Carnegie Steel Company, the open hearth department of Jones and Laughlin, the blast furnace department of Pittsburgh Crucible Steel Company and the coke oven department of the Cambria Steel Company.

In 1916 he went with the Colorado Fuel and Iron Company where he later became plant manager. He joined Republic Iron and Steel Company in 1928 as manager of the Youngstown District. In 1935 he was made manager of Republic's Cleveland District and in 1939 was appointed assistant vice president in charge of operations.

E. M. Richards will assume charge of the operations of Republic Steel Corporation's steel districts, succeeding Mr. Carpenter.

Mr. Richards has been assistant vice president in charge of operations of Republic's manufacturing divisions since 1935. He is a graduate of Bucknell University and was first associated with the Westinghouse Air Brake Company as assistant to the chief engineer. From 1920 to 1925 he acted as a consulting electrical and mechanical engineer and in the latter year was made the chief industrial engineer of the Jones and Laughlin Steel Corporation, Aliquippa Works, where he remained until 1930 when he was appointed chief industrial engineer of Republic.

W. M. Kelley, formerly works manager of the Youngstown plant of Truscon Steel Company, Republic subsidiary, comes to Cleveland to take the position of assistant to the vice president in charge of operations and will have charge of Republic's manufacturing divisions.

A native of New Castle, Pennsylvania, Mr. Kelley's first connection with the steel industry came in 1908 as an apprentice machinist with the New Castle plant of Carnegie Steel Company.

In 1915 he was transferred to Duluth as a mechanical supervisor on the construction of the plant of Minnesota Steel Company, United States Steel subsidiary.

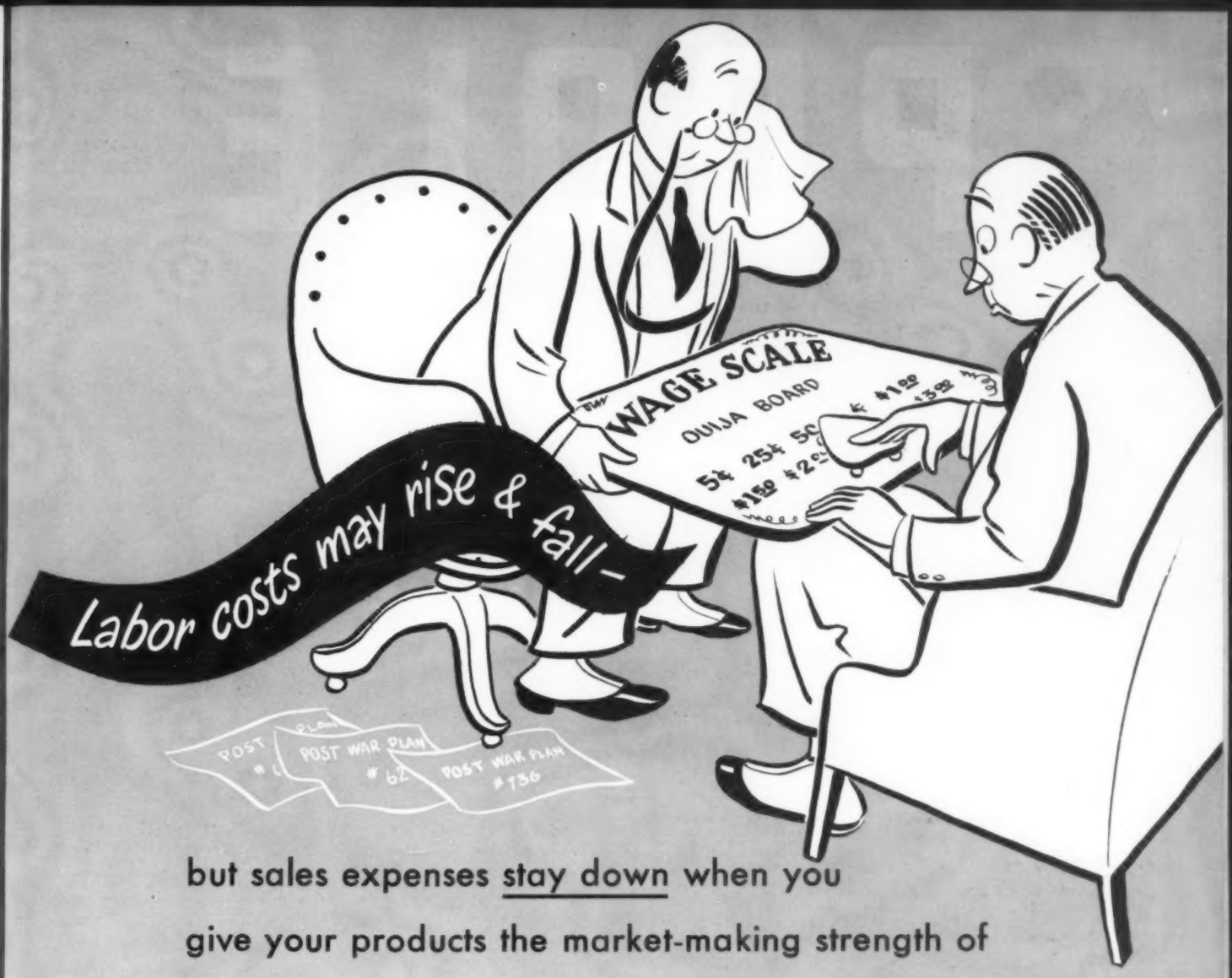
Following six years on this assignment, Mr. Kelley became construction foreman for Inland Steel and subsequently went to Jones and Laughlin Steel Corporation as assistant general master mechanic of the Aliquippa Works, becoming general master mechanic there in 1928.

He joined Republic Steel in 1930 as general master mechanic of the Youngstown plant, becoming works manager of Truscon Steel Company's Youngstown plant six years later.

Obituaries

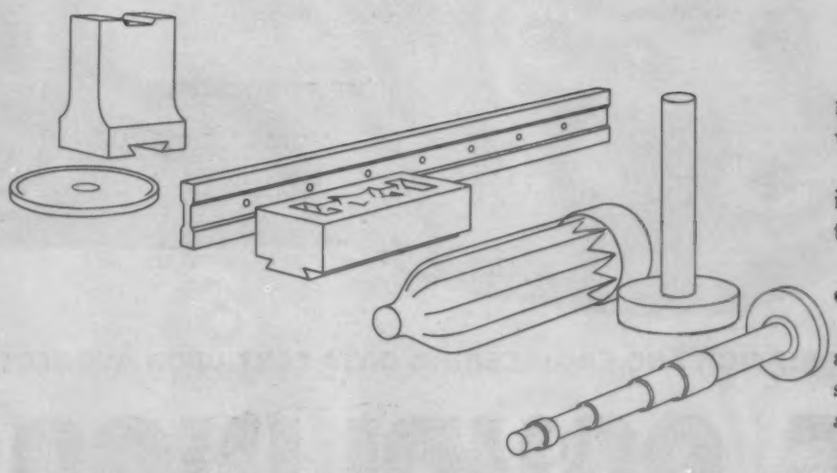
GEORGE E. ADAMS

George E. Adams, electrical superintendent,



but sales expenses stay down when you give your products the market-making strength of

Heppenstall Forgings



HEPPENSTALL COMPANY

Makers of Heppenstall Automatic Safe-T-Tongs

HERE's a post-war plan that will work no matter what happens.

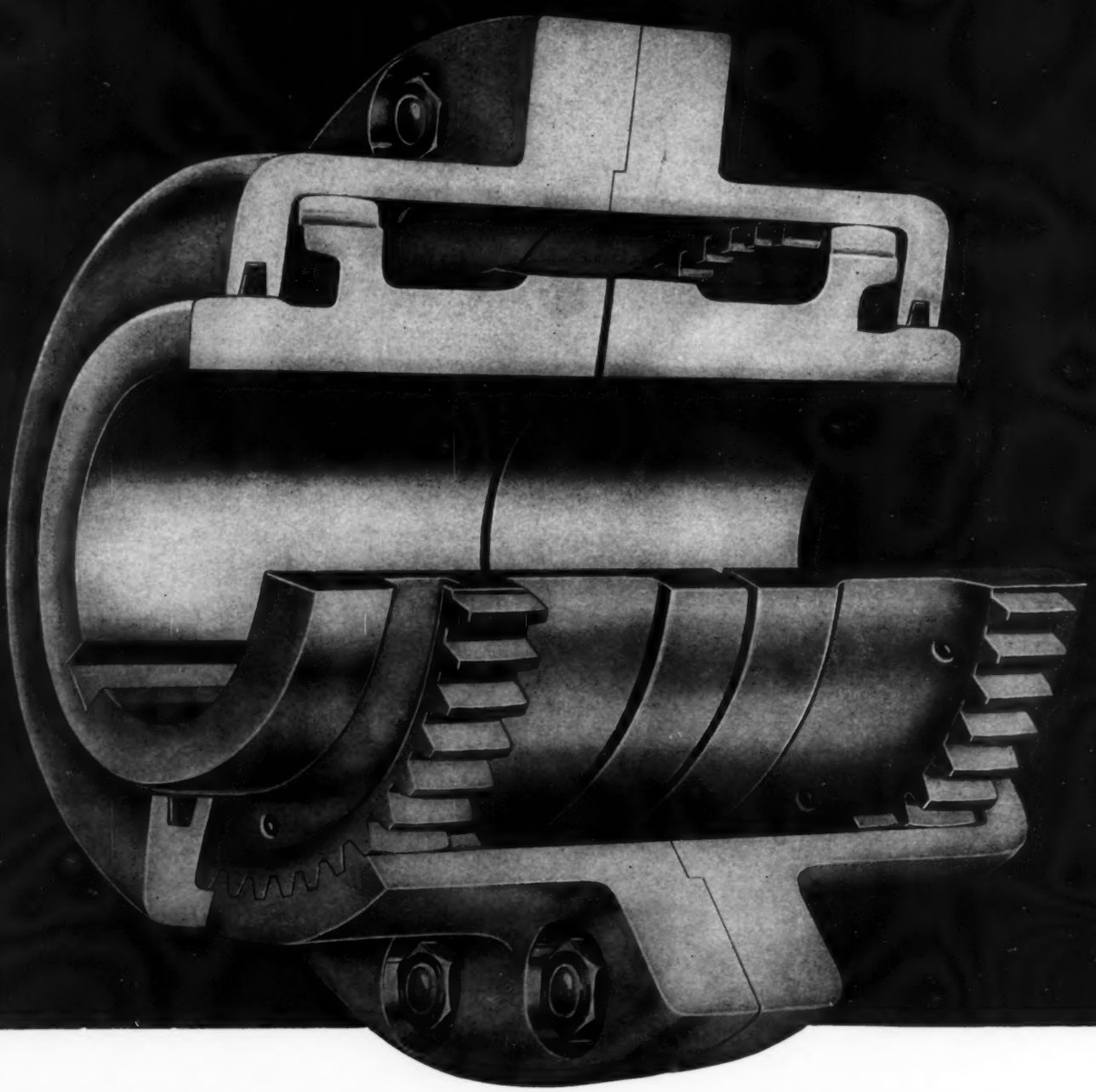
First, build sales-making strength and service into your products by using tough forgings in their vital parts.

Second, reduce production losses by using durable forgings in your own equipment.

This is a tangible, proved and *immediate* approach toward a business stabilizing cut in sales and production costs . . . *It's today's one sure bet.*

When you buy alloy or carbon shafting, rings, back-up roll sleeves, shear knives, die blocks, or alloy steel in ingot or billet *remember* that Heppenstall makes the finest obtainable. On a dollar per service-period basis Heppenstall Forgings can be depended on to show a reduced cost. Write for quotations. Heppenstall Company, Department TP, Pittsburgh, Pa.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Youngstown Sheet and Tube Company, East Chicago, Indiana, died on October 9th.

Mr. Adams was graduated in electrical engineering from Purdue in 1914 and worked in the electrical department of Illinois Steel Company at Gary until 1928. At that time he joined Youngstown Sheet and Tube Company as assistant district engineer and in 1935 was appointed electrical superintendent.

Mr. Adams was active in the affairs of the Association of Iron and Steel Engineers, having served as chairman of the Chicago District Section and as a national director.

Cecil F. Herington, who for many years was in charge of the Amsler-Morton Company's activities in connection with pulverized coal, died in Toledo, Ohio, on September 30th. Mr. Herington was a pioneer in the field of pulverized coal and wrote the first book on the subject, published in this country early in the century. He was responsible for many improvements in the preparation, handling, and burning of this fuel.

A. I. S. E. DISTRICT SECTION MEETINGS

BIRMINGHAM - November 20th

"Steel Conditioning and Foundry Practices with the Oxy-Acetylene Process," by George E. Bellew, Air Reduction Sales Company, New York, New York.

BUFFALO - November 14th

"Coke Oven and Blast Furnace Operation," by J. B. Hill, Superintendent of Blast Furnaces, Bethlehem Steel Company, Lackawanna, New York.

"Production of Light Weight Blast Furnace Slag," by H. O. Wicks, Jr., Assistant Plant Engineer, Hanna Furnace Corporation, Buffalo, New York.

CHICAGO - November 7th

"Control Problems," by P. B. Harwood, Manager of Engineering, Cutler-Hammer, Inc., Milwaukee, Wisconsin.

DETROIT - November 14th

"Fuel Conservation in the Detroit District" — A round table discussion.

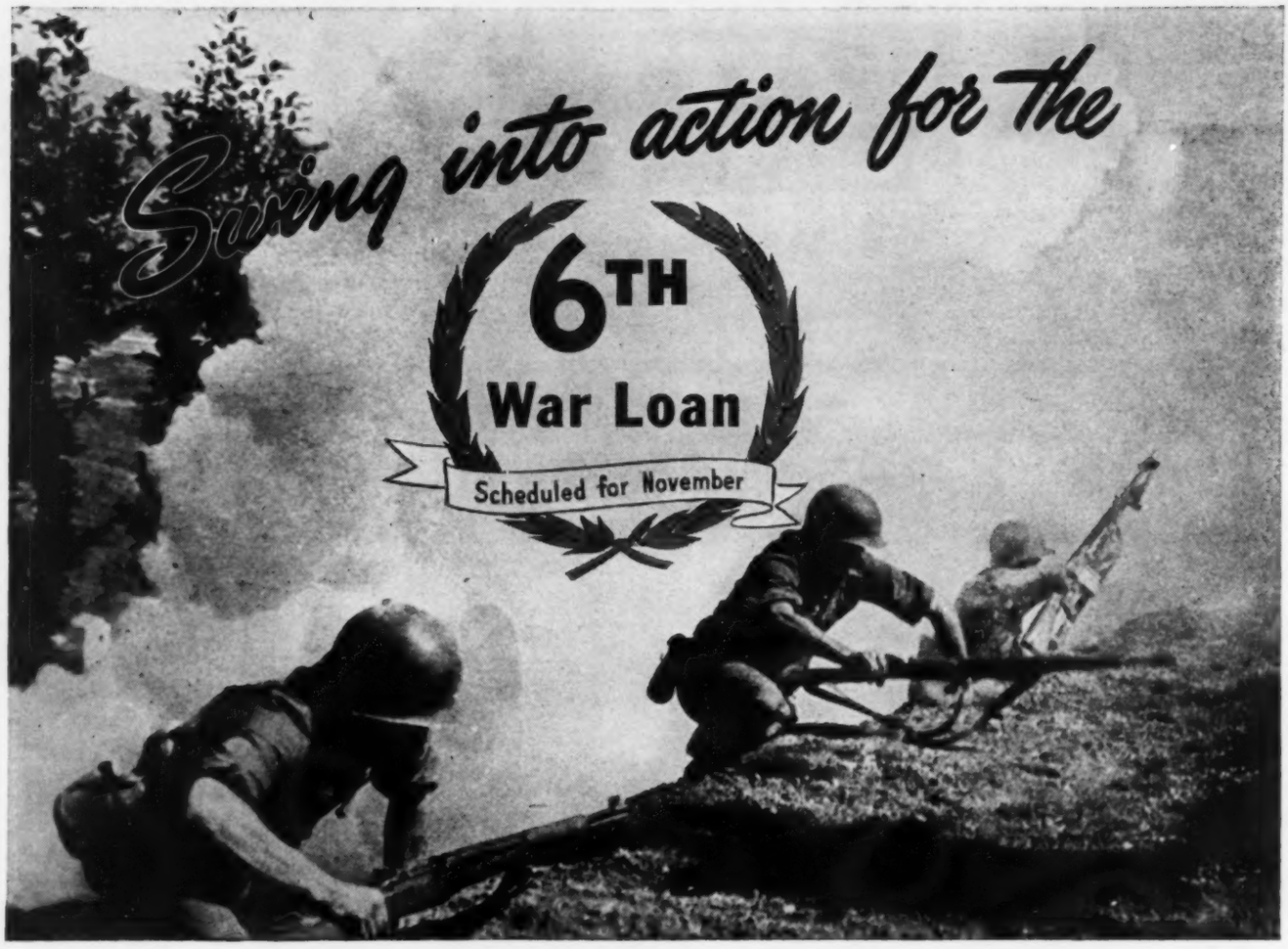
PHILADELPHIA - November 4th

"Relay Protection in Steel Plants," by C. L. Eichenberg, Experimental Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania.

"Some Developments in Transformer Design," by W. W. Satterlee, Division Engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pennsylvania.

PITTSBURGH - November 13th

"The 45 in. Universal Slabbing Mill at Homestead," by A. G. Ericson, Chief Engineer, Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania.



PLAN YOUR PLANT DRIVE NOW!

Good organization will be needed to sell the 6th. The task of raising the huge sum required will be the most difficult ever asked of Industry. As each new military success brings us closer to Victory, the public naturally will feel that the urgency of war financing is lessened—whereas it isn't. So organize now to prevent a letdown on the home-front from causing a letdown on the fighting front. Build your plant's payroll campaign around this fighting 8-Point Plan. You don't have to wait for the official Drive to start—swing into action NOW!

1 **BOND COMMITTEE**—Appoint a 6th War Loan Bond Committee from labor, management and each representative group of the firm.

2 **TEAM CAPTAINS**—Select a team captain, for each 10 workers, from men and women on the payroll—but not in a supervisory capacity. Returned veterans make most effective captains.

3 **QUOTA**—Set a quota for each department and each employee.

4 **MEETING OF CAPTAINS**—Give a powerful presentation of the importance of the work assigned to them. Instruct them in sales procedure. Have them carefully study the Treasury Booklet, *Getting the Order.*

5 **ASSIGNMENTS**—Assign responsibilities for:
- (a) *Music, speeches and announcements of the opening rally.*
- (b) *Pre-drive letter to employees from management and labor.*
- (c) *Competitive progress boards.*
- (d) *Meeting schedules, etc.*

6 **CARD FOR EACH WORKER**—Dignify each personal approach with a pledge, order, or authorization card made out in the name of each worker. Provide for a cash purchase or installment pledge. Instruct each captain to put a pencil notation on the card to indicate the subscription he expects to solicit from each worker.

7 **RESOLICITATION**—People don't mind being asked to buy more than once. Resolicit each employee toward the end of the drive in a fast mop-up campaign. Call upon your State Payroll Chairman; he's ready with a fully detailed plan—NOW!

8 **ADVERTISE THE DRIVE**—Use all possible space in the regular media you employ to tell the War Bond story.

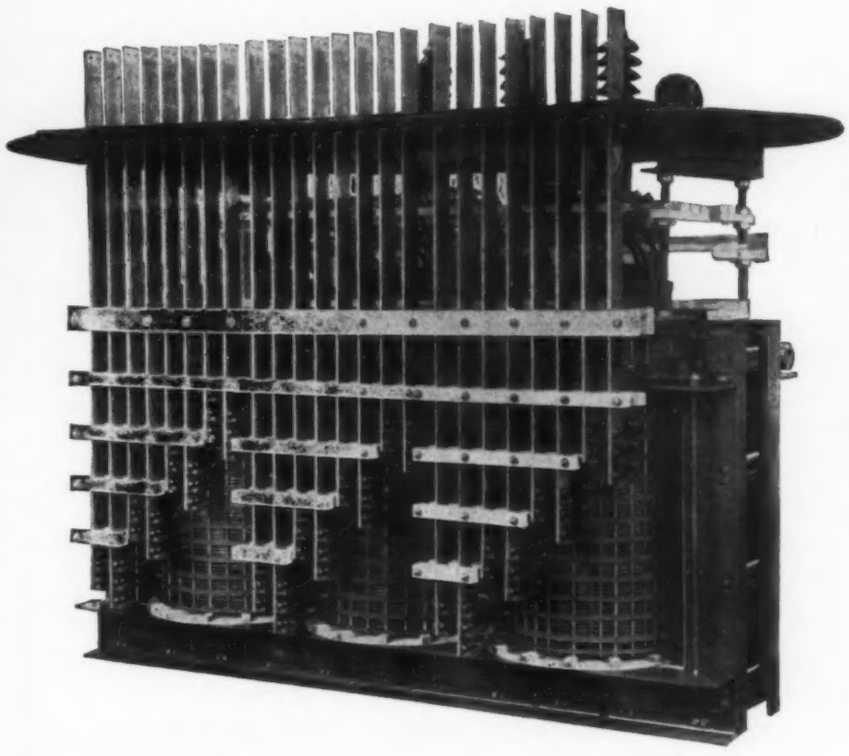
The Treasury Department acknowledges with appreciation the publication of this message by

Iron and Steel Engineer

This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council

FURNACE TRANSFORMER *Facts*

★ The transformer that supplies power to an electric furnace is an extremely complicated unit. The rules governing ordinary designs and construction of Power Transformers do not apply to Furnace Transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship.



Pennsylvania Transformer Company has acquired a noted reputation in the Furnace Transformer field. For over thirty years its engineers have closely followed the development of electric furnaces. They fully understand the problems of Electric Furnaces and their relation to Furnace Transformers.

1. OVERLOADS & SHORT CIRCUIT STRESSES

Electric Furnace operation inherently subjects Furnace Transformers to frequent short circuits and heavy overloads. The effect of this on the transformer is complicated by the wide range of voltages which necessitates cutting out large portions of the primary windings. The effects of both the radial and axial short circuit forces are greatly reduced in Pennsylvania Furnace Transformers by the use of Circular Coils and an ingenious winding arrangement.

•

2. BALANCING OF STRESSES

Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. 1. The circular shape protects the coils against deformation due to radial short circuit forces. 2. The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in a three hundred ton hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

•

3. DISTRIBUTION OF CURRENTS

Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A skillful arrangement of the windings insures that each section carries an equal share of the current. Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

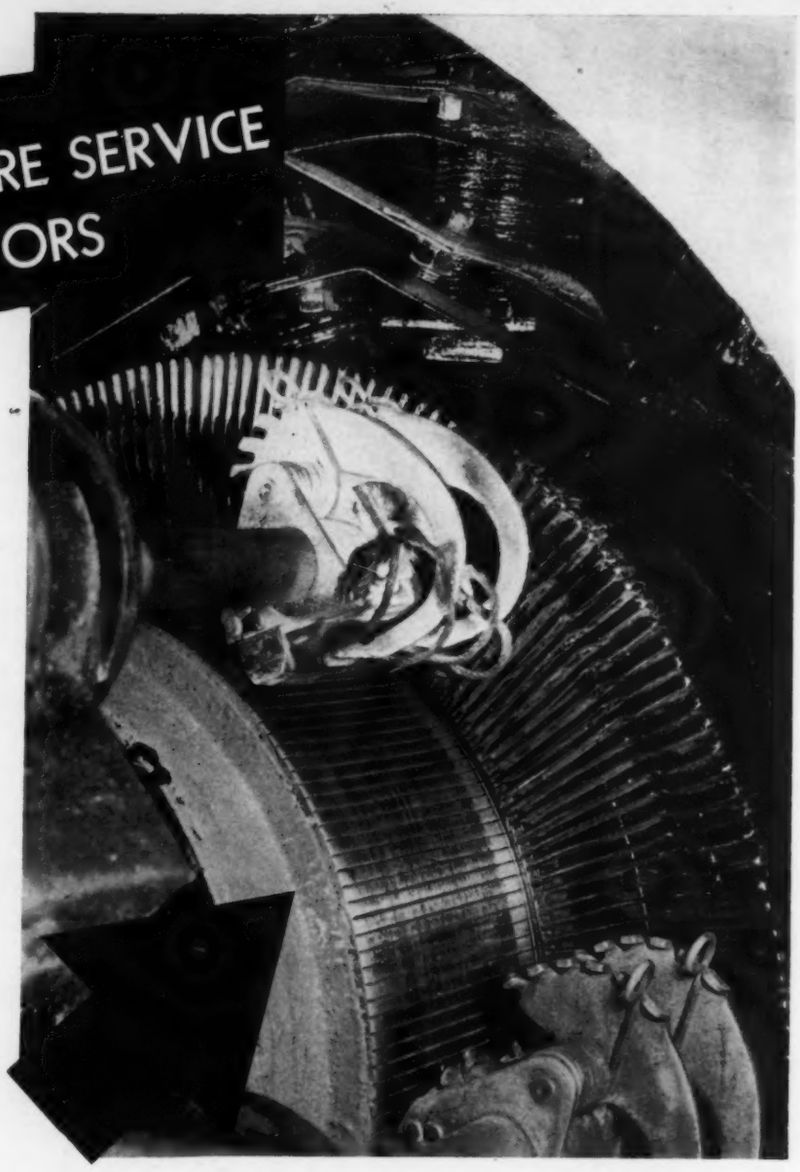
•

Send your furnace transformer inquiries to Pennsylvania Furnace Transformer Experts.

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

HOW TO GET MORE SERVICE FROM MOTORS



Carbonization of the lubricating and cutting oils that seep into the interstices of commutator segments is largely responsible for the burnouts that occur under overload operation, particularly on non-interpole machines. The inductance voltage between bars during commutation may be high enough to cause arcing after the bars have passed under the brushes and any lubricating oil that has deposited on the mica segments may be carbonized to the extent that actual current flow is permitted from bar to bar.

Thoroughly cleaning the commutator prior to an application of one of DOLPH'S oilproof enamels on the exposed end of the commutator will help to prevent these shorts.

On certain types of commutators that have been in service for some time, shrinkage of the mica segments occurs. This is largely due to the fact that mica segments are built up with mica laminations and these laminations are cemented together with a binder. Aging of the binder may result in a slight change in mica dimensions thus opening capillary cracks which encourage oil seepage and absorption.

An application of one of DOLPH'S oilproof enamels will prevent oil seepage. However, it is suggested that commutator ends be thoroughly cleaned before attempting to apply the enamel.

FOR EXTRA PROTECTION

USE DOLPH'S OILPROOF ENAMELS

Synthite No. 10 Red Insulator - Dolflex No. 3 Red Enamel

Synthite No. 157 Red Insulator - No. 81 Red Oilproof Enamel

Further information regarding the use of Oilproof Enamels will gladly be supplied upon request.

Dolph's

JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

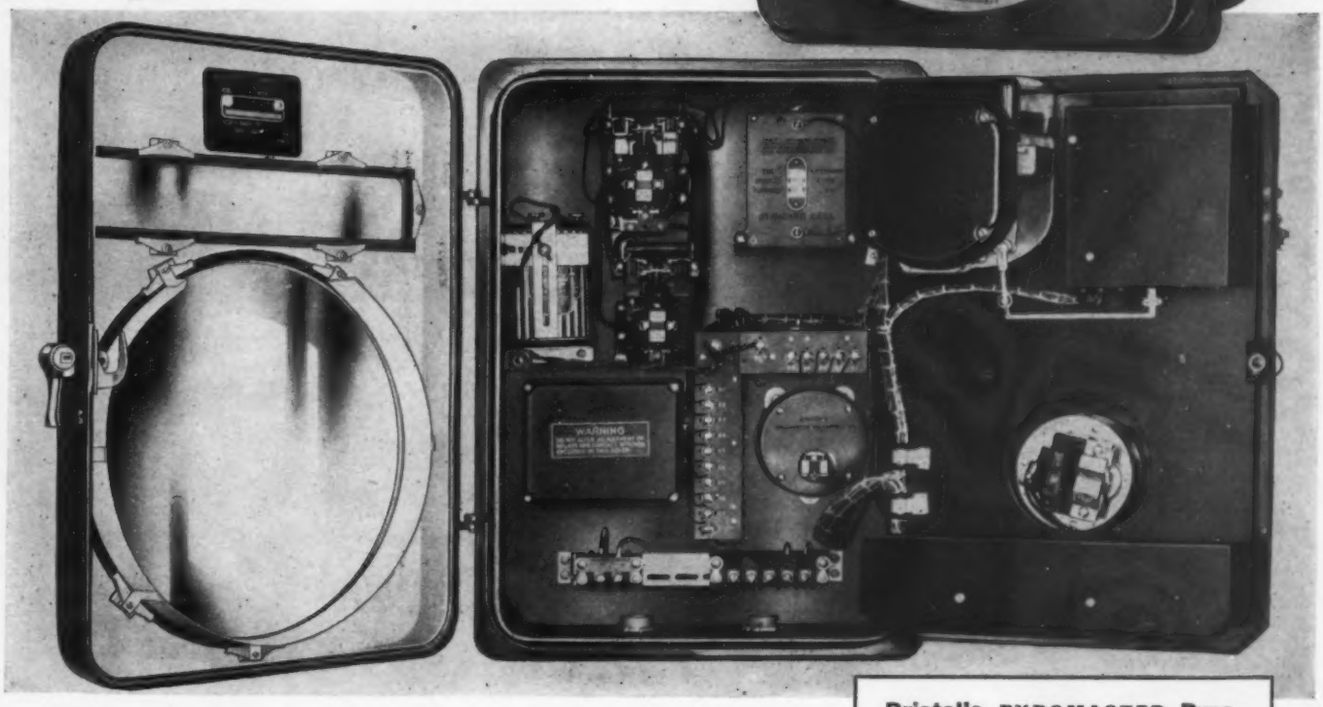
166A EMMETT ST. NEWARK, N. J.

Bristol's PYROMASTER

A Self-balancing Potentiometer for Recording, Indicating and Controlling Industrial Processes

REDESIGNED EMBODYING NEW FEATURES

1. Hinged panel for accessibility.
2. Standard Cell for accuracy.
3. High-torque motor for ruggedness.
4. Totally enclosed relays and galvanometer.
5. Enclosed tarnish-resistant slide-wire.
6. Large easily read straight-line scale.



Pyromaster Pyrometer Electric-Type Controller, door open and panel swung out

ALL PARTS ACCESSIBLE: All parts of the Pyromaster are accessible even when the instrument is in full operation. The dial and recording mechanisms are mounted on the front of a hinged reinforced steel panel, which can be swung out of the case as shown above. The slide wire and potentiometer mechanism and, in the case of controllers, the control mechanism are mounted on the back of the panel. Each part or unit can be serviced in place or removed without disturbing any other part.

Bristol's PYROMASTER Pyrometers are available in the following types of instruments for temperatures up to 3600° F.

Electric-Type Controllers
Air-Operated Controllers
Single-Pen and Two-Pen Recorders
Dial Indicators
Time-Temperature Controllers
Radiation Pyrometers

Complete facts in Bulletin P1200. Address 123 Bristol Road

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... Gives YOU the Most from Heat

THE BRISTOL COMPANY, Waterbury 91, Connecticut

The Bristol Co. of Canada, Ltd.
Toronto, Ontario

Bristol's Instrument Co., Ltd.
London, N. W. 10, England

AND SAVE MACHINING, LUBRICANT AND POWER

You're doing right by your roll necks when you lubricate them with Dixon's Roll Neck Graphited Grease. It's made expressly to lengthen the life of necks and brasses by preventing premature wear and scoring. You favor your costs, too, with Dixon's because it saves lubricant, maintenance labor and machining time. Cuts power bills by keeping necks free-running. Especially valuable for mills with plain bearings. Write department RN-50 for proof.

Write for Directory (shown at the left), which lists and illustrates 24 LOOSE LEAF Pages of miscellaneous graphite products, many of which are widely used in the metal industries.

JOSEPH DIXON CRUCIBLE CO., JERSEY CITY 3, N. J.

Canada: Canadian Asbestos Company • Montreal • Vancouver • Toronto • Winnipeg

Graphite Seal • Graphited Oils • Cup and Pressure Gun Grease • SlipStik Gear Lubricants • Waterproof Graphited Grease • Auto-Marine Grease Industrial Oven Lubricant • Lathe Center Graphite Lubricant Graph-Air Guns • Welding Rods • Belt Dressing (Contains no Graphite)

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- ☐ MARKING MACHINES
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- ☐ METAL CHECKS—BADGES
- ☐ NAME AND IDENTIFICATION PLATES

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Check This Ad
Attach To Your
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And Return To

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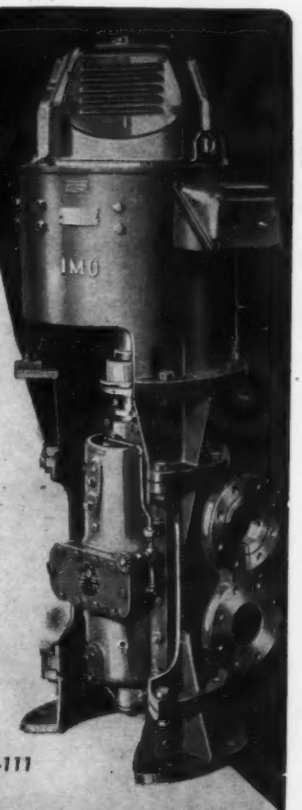
The MOST PUMP in least Weight & Space



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Ask for Publication I-111

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HEAVY BEVEL

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MOTOR CONTROL

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Source of World Supply

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With NATIONAL ROLLS, we have kept abreast of the best metallurgical thought and advances in roll-making method, and like other makers of good rolls, await post-war demand with confidence.

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All Grades of Cast Rolls-Iron and Iron Alloy-Steel and Steel Alloy
Heavy Iron Castings and Rolling Mill Equipment

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Maximum Lift MAGNETS

A standard 65" Ohio Magnet Lifting 5200 lbs. of Pig Iron

Standard round general purpose Ohio magnets are built in sizes from 12" to 65" in diameter.

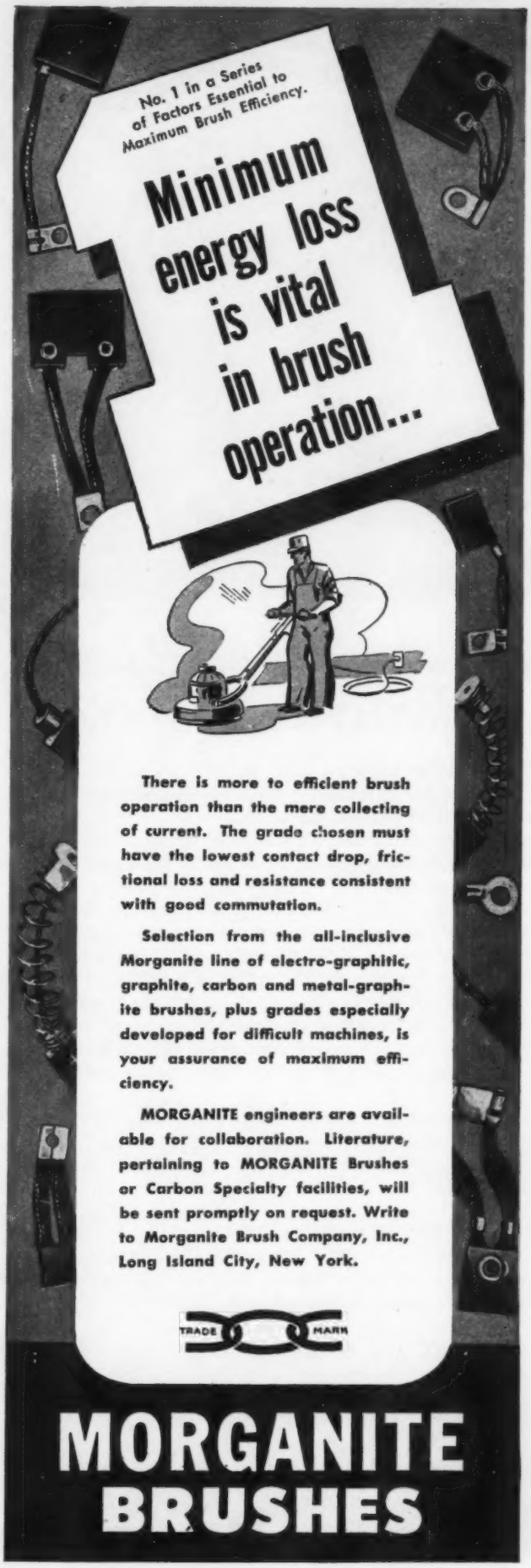
Average lifting capacity for pig iron or scrap ranges from 200 lbs. to 6200 lbs.

Depending upon the amount of material to be handled, the largest suitable magnet will do it most economically.

Labor cost per lift is the same whether the lift be 200 lbs. or 6200 lbs.

THE OHIO ELECTRIC MFG. COMPANY

5907 Maurice Ave. **Cleveland 4, Ohio**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There is more to efficient brush operation than the mere collecting of current. The grade chosen must have the lowest contact drop, frictional loss and resistance consistent with good commutation.
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MORGANITE
BRUSHES

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Nine out of ten are due to oil escaping from bearings and soaking windings. The result is a short circuit and "burn-out."

NON-FLUID OIL stops this trouble. It does not leak or creep, nor is it thrown out of bearings by vibration. Motors are kept running steadily, with cool bearings and clean frames. Money is saved on lubricant and application cost, because NON-FLUID OIL lasts longer and needs less frequent renewal.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

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NON-FLUID OIL
IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

"Continuous Balance" + PLUS Air-o-Line Control
MARKS A NEW ERA IN THE TREATMENT OF METALS

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TO POSTWAR
INSTRUMENTATION

see the
ELECTRONIK
in operation at
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BOOTH
F 601

"*CONTINUOUS BALANCE*" is a new principle in pyrometry. It makes the Brown *ElectroniK* Potentiometer an outstanding advance in instrumentation —probably the greatest step forward in several decades.

In this advanced potentiometer controller, the "*Continuous Balance*" unit takes the place of the galvanometer used in conventional mechanical-type potentiometers employing a periodic or cyclic mechanism.

The Brown *ElectroniK* Potentiometer Air-Operated Controller provides the ideal synchronization of measurement and control for temperature processes. What "*Continuous Balance*" does for measurement—"*Air-o-Line* Control" does for fuel modulation, being capable of infinite fineness in full valve adjustment. It is the only potentiometer-type controller in which the air-controlled flapper mechanism is continuously positioned in response to temperature changes.

Used with conventional wiring and thermocouple installations, Brown *ElectroniK* Potentiometers are rapidly outmoding all other forms of temperature controllers in heat-treating processes.

Thousands of operating hours have proved the Brown *ElectroniK* Potentiometer's superior performance—sensitivity—and ruggedness. Its electronic "*Continuous Balance*" principle makes it possible to take full advantage of thermocouple responsiveness, which means precise control with uniformity hitherto impossible.

Write for Catalog 15-4, THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Company*, 4503 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities. 119 Peter Street, Toronto, Canada—Wadsworth Road, Perivale, Middlesex, England—Nybrokajen 7, Stockholm, Sweden.

Balance Must Be Continuous

BROWN *Electronik*
POTENTIOMETERS

INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 1
Air Reduction Sales Company 9
Allis-Chalmers Manufacturing Company 32
American Brakeblok Division, American Brake Shoe Company 20
American Bridge Company R-52
American Hammered Piston Ring Division of Koppers Company 68, 69
Askania Regulator Company R-48

B

The Babcock & Wilcox Company R-4
Wm. M. Bailey Company R-58
Baker-Raulang Company 22
Bantam Bearings Division, The Torrington Company 16
Bartlett-Hayward Division of Koppers Company 68, 69
Birdsboro Steel Foundry and Machine Company 67
Bonnot Company 8
Bristol Company 91
Broden Construction Company 10
Brown Instrument Company 96
Bussmann Manufacturing Company R-44, R-45

C

Cities Service Oil Company R-59
Clark Controller Company R-50, R-51
Cleveland Crane and Engineering Company 29
Cleveland Worm and Gear Company R-67
Continental Foundry and Machine Company R-10, R-11
Crocker-Wheeler Manufacturing Company 11
Crouse-Hinds Company 79
M. E. Cunningham Company 93
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Company 71, 92
M. H. Detrick Company R-5
Joseph Dixon Crucible Company 92
John C. Dolph Company 90

E

Electric Controller & Manufacturing Company R-2
Engineering and Construction Division of Koppers Company 68,69

F

Farrel-Birmingham Company, Inc. 72
Farval Corporation R-68
Fitch Recuperator Company 30, 31
Flinn and Dreffin Company 10
Freyn Engineering Company R-12

G

Gas and Coke Division of Koppers Company 68, 69
Gatke Corporation 65
General Electric Company ..... Cover 4

H

Hallden Machine Company 10
Hays Corporation 78
Heppenstall Company 87
Heyl and Patterson, Inc. R-56, R-57
Hydropress, Inc. 3

I

Illinois Clay Products Company R-53
Ingersoll-Rand Company R-7
International Nickel Company 18
I-T-E Circuit Breaker Company ..... Cover 3

J

Johns-Manville Corporation 84

K

C. M. Kemp Manufacturing Company 80
Koppers Coal Company 68, 69
Koppers Company 68, 69
Koppers Rheolaveur Company 68, 69

L

Lamson Corporation R-55
Leeds and Northrup Company R-17
Lewis Foundry and Machine Division, Blaw-Knox Company 14
Link-Belt Company R-14
Lincoln Engineering Company 15

M

Mackintosh-Hemphill Company 17
Maryland Drydock Company 68, 69
Jas. H. Matthews and Company 92
McKay Machine Company 10
Mesta Machine Company ..... Cover 1, R-15
Morgan Construction Company 23
Morgan Engineering Company R-16, R-64
Morganite Brush Company 95

N

National Bearing Metals Corporation 24
National Carbon Company, Inc. 27, R-13
National Roll and Foundry Company 94
New York and New Jersey Lubricant Company 95
Norma-Hoffmann Bearings Corporation 98

O

Ohio Electric Manufacturing Company 94
Ohio Steel Foundry Company 26
Okonite Company 21

P

Pennsylvania Industrial Engineers R-65
Pennsylvania Transformer Company 89
Philco Corporation, Storage Battery Division R-9
Pittsburgh Lectromelt Furnace Corporation 34
Plymouth Locomotive Works, Division of Fate-Root-Heath Company R-62
William B. Pollock Company R-54
Poole Foundry and Machine Company 88
Post-Glover Electric Company 70
Pyle-National Company 81

R

Reliance Electric and Engineering Company 4
Rockbestos Products Corporation 49
Rollway Bearing Company, Inc. 83
Rowan Controller Company 58, 93
Fred J. Ryan Company 44

S

Salem Engineering Company 19
Schloemann Engineering Corporation 74
SKF Industries, Inc. 66
Soconoy-Vacuum Oil Company, Inc. 13
James Stewart & Company, Inc. R-66
Surface Combustion R-60, R-61
Swindell-Dressler Corporation 5

T

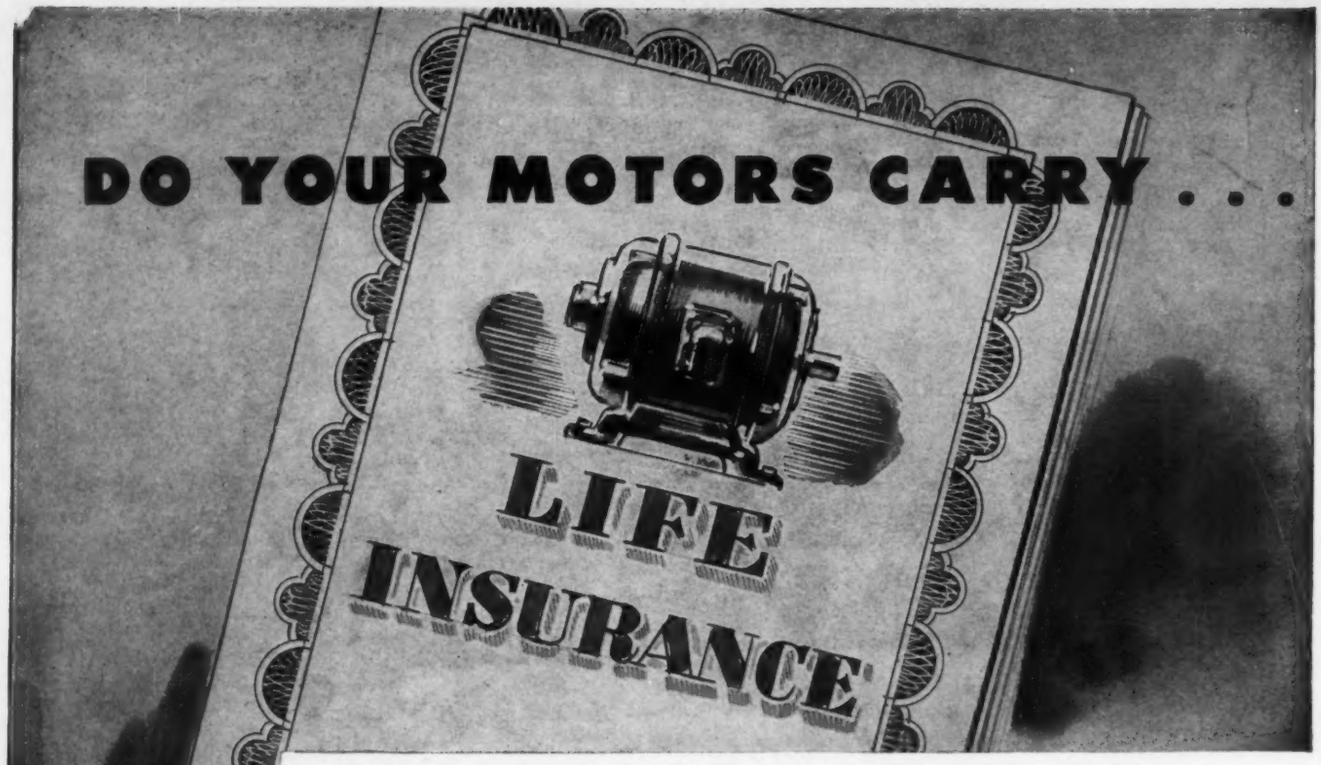
Tar and Chemical Division of Koppers Company 68, 69
Tate-Jones and Company, Inc. 77
Thomas Flexible Coupling Company 82
Tide Water Associated Oil Company 6, 7
Timken Roller Bearing Company R-43
Tool Steel Gear and Pinion Company R-3
The Torrington Company, Bantam Bearings Division 16
Trabon Engineering Corporation R-49
M. H. Treadwell Company R-63

U

United Engineering and Foundry Co. 25, R-6
Union Carbide and Carbon Corp. 27, R-13

W

Wagner Electric Corporation R-46, R-47
Wapakoneta Machine Company 93
Wean Engineering Company, Inc. 10
Wean Engineering Company of Canada, Ltd. 10
Wellman Smith Owens Engineering Corporation, Ltd. 10
Western Gas Division of Koppers Company 68, 69
Westinghouse Electric and Manufacturing Company 12, R-8
White Tar Company of New Jersey, Inc. 68, 69
Wilputte Coke Oven Corporation ..... R-39 - R-42
Lee Wilson Engineering Company 2
Wood Preserving Corporation 68, 69



The life of a motor is no longer than the life of its bearings. Bearing failure means motor failure and shutdowns. And the bearings may fail for any or all of the following reasons:—(a) poor design and construction; (b) neglected lubrication; (c) use of lubricant of poor quality; (d) dust and dirt in the bearings.

MOTOR MANUFACTURERS WHO HAVE ADOPTED NORMA-HOFFMANN "CARTRIDGE" BALL BEARINGS ARE PROVIDING THEIR CUSTOMERS IN-BUILT MOTOR LIFE INSURANCE--IN EFFECT, A GUARANTEE OF LONGER, MORE TROUBLE-FREE, LOWER-COST MOTOR PERFORMANCE—because:—

A. The "CARTRIDGE" BEARING is a NORMA-HOFFMANN PRECISION product, designed EXPRESSLY to meet electric motor requirements.

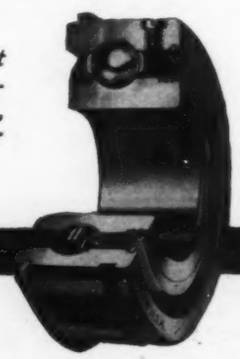
B. With its double-row width, the "CARTRIDGE" BEARING provides WITHIN ITSELF a supply of lubricant at least twice that of any other single-row ball bearing.

C. The "CARTRIDGE" BALL BEARING is loaded at the factory with NORMA "STABILITY-TESTED" GREASE—a high-duty lubricant which has exceptional life and a wide temperature range, and moreover is chemically stable and water-repellent.

D. The highly efficient, wearless metal seals of the "CARTRIDGE" BEARING, so effective in KEEPING LUBRICANT IN the bearing, are equally effective in KEEPING DUST AND DIRT OUT. And they are removable and replaceable, making bearing inspection easy.

These, and other, distinctive features explain why so many motor manufacturers, seeking to assure their customers MAXIMUM MOTOR LIFE, have adopted NORMA-HOFFMANN "CARTRIDGE" BALL BEARINGS for their latest and most efficient motor models.

Ask for motors carrying the "life insurance" that NORMA-HOFFMANN "CARTRIDGE" BEARINGS provide. They will be a sound and lasting investment, returning good dividends in lower costs, longer life, and freedom from shutdowns.



NORMA-HOFFMANN BEARINGS CORP'N, STAMFORD, CONN. FOUNDED 1911

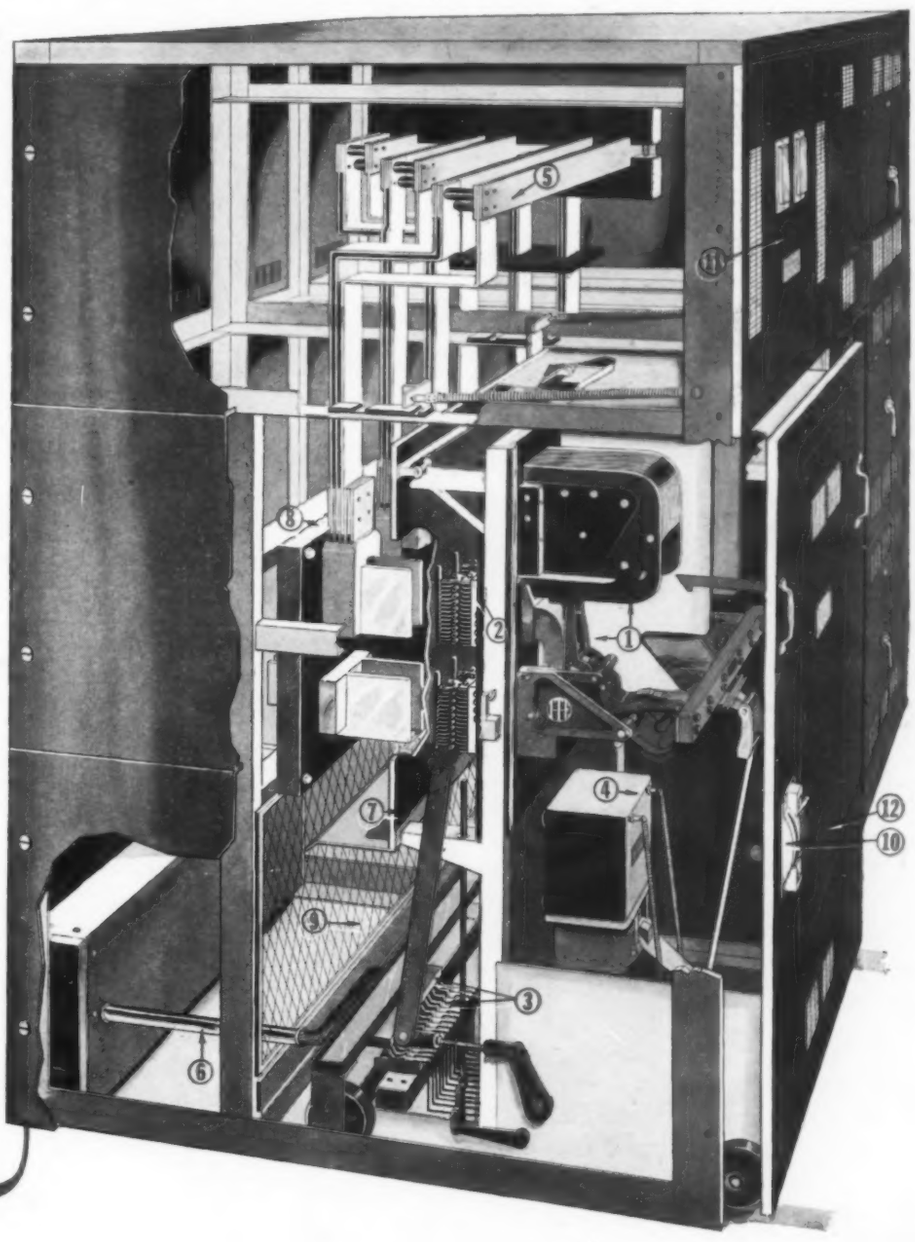
TO WIN THE WAR • WORK • FIGHT • BUY WAR BONDS

Truck Mounting Details

IN I-T-E STEEL-CLAD SWITCHGEAR

Features identified in this cutaway view show I-T-E design working in the interest of the switchgear purchaser. They are typical of the I-T-E approach to the making of switchgear; they promote safety, convenience and long life—and reduce maintenance. Other arrangements that would "work" might be devised but they would not be "I-T-E" unless they also protected the user's investment.

For more details on the features of I-T-E drawout switchgear, send for Bulletin 4207—"Multumite Switchgear Assemblies, Drawout Type." Your request for a copy may be forwarded to the I-T-E representative nearest you or directly to I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.



1. **LARGE AIR CIRCUIT BREAKER**—To save handling time, drawout type breakers rated 2000 amperes and above are mounted in trucks.
2. **PRIMARY DISCONNECTING DEVICES**—Safe inspection, away from live parts, is provided by mounting the self-aligning fingers on the truck. Silver surfaces prevent overheating.
3. **SECONDARY DISCONNECTING DEVICES**—For control and other small wiring. Silver-surfaced contacts are closed at Test Position.
4. **ELECTRIC OPERATING MECHANISM**—Dependable operation and low current demand are attained with this trip-free, solenoid mechanism.
5. **SILVER-SURFACED BUSES**—Silver gives lasting immunity from overheating at the joints.
6. **CONTROL WIRING CONDUIT**—Connects to covered terminal box.
7. **PROTECTION SHEET**—Covers live contacts when truck is withdrawn from housing.
8. **MALE DISCONNECTING-DEVICE BASE.**
9. **SAFETY SCREEN.**
10. **POSITION-INDICATOR HOUSING** — Also encloses trip and reversing linkage handle, and socket for drawout lever.
11. **HINGED INSTRUMENT PANEL**—Provides ample space for instruments, meters, transfer switches and test blocks.
12. **HINGED DOOR**—Gives free access to circuit breaker and operating mechanism for inspection and testing. Door may be opened without taking breaker out of service.

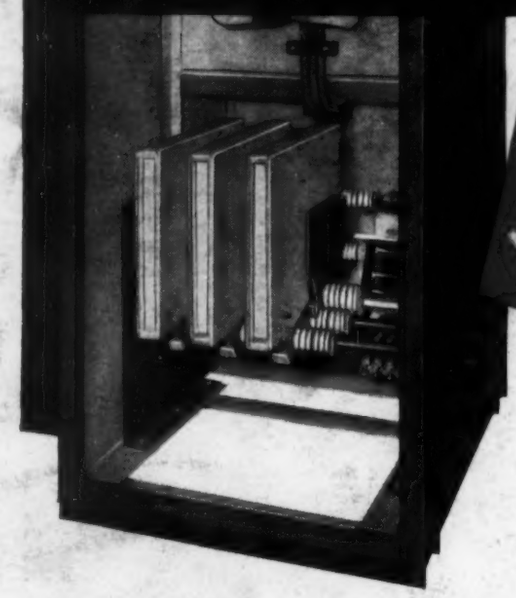
I-T-E

Representatives in Principal Cities

AIR SWITCHGEAR

ARMY NAVY I-T-E

Why LIMITAMP CONTROL is good for MILLIONS of operations



NEW AIR-BREAK CONTACTORS

Daily demonstrating their remarkable stamina in severe repetitive service

THESE new contactors meet the most severe requirements of high-voltage motor-control service. Their design gives them a mechanical life of millions of operations. Contact-tip life of many times the life of comparable oil-immersed tips makes these air-break contactors the logical answer for any severe duty—in steel mills, rubber mills, etc. The current-limiting fuses, Type EJ-2, are an especially important feature. They operate in a split cycle. When a short occurs, they cut off the rise in current in less than a quarter cycle, and clear it in less than a half cycle—long before the short has had time to harm the contactor or motor.

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1. *Personnel protection*—Totally metal-enclosed, Limitamp controls give protection to operating personnel.

2. *Overload protection*—Isothermic overload relays, calibrated accurately against actual motor characteristics, protect the motor from overheating due to sustained overloads or single-phasing.

3. *Undervoltage protection*—All Limitamp controllers can be furnished with instantaneous or time-delay undervoltage protection.

YOU'LL WANT TO KNOW all about this motor control. How separate compartments for the high- and low-voltage circuits protect the operator. How a group of these starters can be fitted together to give you a neat, compact control panel. Our local sales engineers will be glad to help you select a control to fit your application. *General Electric Company, Schenectady 5, N. Y.*

Buy all the BONDS you can—and keep all you buy

GENERAL ELECTRIC 676-161-8900

INDUSTRIAL CONTROL